Guidebook

Microcost Methods for Determining VA Healthcare Costs

Mark W. Smith, Paul G. Barnett, Ciaran S. Phibbs, and Todd H. Wagner

February, 2010

Microcost Methods for Determining VA Healthcare Costs

Health Economics Resource Center (HERC)
VA Palo Alto Healthcare System
795 Willow Road (152 MPD)
Menlo Park, CA 94025
650-617-2630
650-716-2639 (fax)
herc@va.gov

Suggested citation: Smith MW, Barnett PG, Phibbs CS, Wagner TH. Microcost methods of determining VA healthcare costs. Menlo Park, CA: Health Economics Resource Center, 2010.

Acknowledgements: This research was funded by the VA HSR&D Service (ECN 99-017) and the VA Cooperative Studies Program (CSP #146). The analyses and conclusions are the authors' own and do not necessarily represent the views of the U.S. Department of Veterans Affairs.

Note on Succession: This replaces an earlier edition of the guidebook dated December, 2005.

Contents

Tables and Exhibits

Terms

ABC	Activity-based costing
AITC	Austin Information Technology Center
ALBCC	Account Level Budget Cost Center
APC	Ambulatory Payment Categories
AWP	Average Wholesale Price
BOC	Budget Object Codes
CBOC	Community-based Outpatient Clinic
CDA	Cost Distribution Accounts
CDR	Cost Distribution Report
CMS	Centers for Medicare and Medicaid Services
CPT	Current Procedure Terminology Codes
DRG	Diagnosis Related Group
DSS	Decision Support System
FMS	Financial Management System
FTC	Functional Task Code
FY	Fiscal Year
HERC	Health Economics Resource Center
IRB	Institutional Review Board
ISO	Information Security Officer
KLFMenu	The website of the VISN Support Services Center
LOS	Length of stay
MCCR	Medical Care Cost Recovery
MPCR	Monthly Program Cost Report
NDC	National Drug Code
NDEs	National Data Extracts
NPCD	National Patient Care Database
NPPD	National Prosthetics Patient Database
OPC	Outpatient Care file
PAID	VA payroll system
PBM	Pharmacy Benefits Management Database
PTF	Patient Treatment file
RVUs	Relative Value Units
VA	Department of Veterans Affairs
VERA	VA Veterans Equitable Resource Allocation
VHA	Veterans Health Administration
VIReC	Veteran Affairs Information Resource Center
VISNs	Veterans Integrated Service Networks
VistA	Veterans Health Information Systems and Technology Architecture

1. Overview

1.1 Introduction

The purpose of this guidebook is to introduce researchers to microcosting, a set of related methods for determining the cost of healthcare. It explains microcost methods and provides guidance on using them with data produced by the Department of Veterans Affairs (VA), but many of the principles that are described apply to other healthcare systems. Researchers new to the VA or new to cost analyses often have many questions about institutional matters, and it is these readers we have kept in mind when writing the handbook. We hope it will be a useful reference for more experienced researchers as well. To that end, it will be updated as needed to stay abreast of development in VA data systems and advances in research.

The guidebook is organized as follows. Chapter 2 provides an overview of datasets that may be used to determine costs of VA care. Chapter 3 briefly describes the Cost Distribution Report (CDR) and its successor, the Monthly Program Cost Report. Chapters 4 through 7 describe three alternative methods of microcosting: direct observation and measurement (Chapter 4), creation of pseudo-bills (Chapters 5-6), and statistical cost functions (Chapter 7). Chapter 8 covers two topics that have received little attention heretofore: malpractice payments and the cost of capital.

This guidebook is produced by the Health Economics Resource Center (HERC). Several additional guidebooks are available on the HERC intranet web site. One concerns the Financial Management System (FMS), the VA general ledger (Smith and Barnett 2010). Two others deal with average-cost methods. Average costing for inpatient stays is described in *HERC's Average Cost Datasets for VA Inpatient Care FY1998 - FY2008* (Wagner and Barnett 2009). A similar guidebook for outpatient visits is *HERC'S Outpatient Average Cost Dataset for VA Care: Fiscal Year 2008 Update* (Phibbs et al. 2009). The guidebook *Research Guide to Decision Support System National Cost Extracts* (Phibbs et al. 2008) details the structure and contents of an encounter-level extract from the Decision Support System. Each of the handbooks is available on request and on the HERC intranet site.

There are additional sources of information on microcost methods as well. The HERC web site contains a number of short pieces ("FAQ" responses) pertaining to microcosting. HERC has also developed presentations on costing methods, available in both audio and visual formats. Many of these may be downloaded directly from the HERC web site; others will be sent on request.

A standard reference on cost-effectiveness analyses is the 1996 report of a Public Health Task Force on cost-effectiveness (Gold et al., 1996). It recommends use of microcosting and average-costing methods, discusses methodological issues in detail, and offers many specific recommendations on carrying out cost-effectiveness analyses. The microcost methods described in this handbook are consistent with the guidelines set forth in the Task Force report wherever possible. Another source, less theoretical than the Gold book, is Muennig (2002).

1.2 When to Use Microcosting

Cost-effectiveness, cost-utility and cost-outcome analyses are major components of health economics research. What they have in common is the need to measure the cost of healthcare activity. Three methods for doing so in the context of VA care are microcosting, average costing, and using the Decision Support System (DSS). The methods differ in their level of detail. In microcosting, a cost is derived for each element of an intervention: staff time, supplies and medications, out-of-pocket expenses, and so on. The DSS National Data Extracts (NDE) allow costs to be determined by patient, day, and bedsection, but costs are not broken down into units of staff time, medication cost, etc. The highest level of aggregation is found in the average-costing approach. Here, mathematical models are used to determine the mean cost of a day of inpatient care or an outpatient visit. With average costing, there is no detail available on the cost of any component of the stay or visit.

A common method for determining VA costs is average costing. In average costing a researcher combines VA utilization data, relative values for costs of care derived from non-VA cost datasets, and department costs obtained from a department-level cost database. Every encounter with the same characteristics is assumed to cost the same. Relative values may be the Medicare relative weights associated with the Diagnosis Related Group of an inpatient stay, or the reimbursement associated with an outpatient procedure code. In many studies, and for some of the healthcare utilization in nearly every study, an average-cost method can be used. HERC has prepared a comprehensive set of estimates of the cost of VA care using average-cost methods (Wagner et al., 2005; Phibbs et al., 2004).

The Decision Support System (DSS), a computerized cost-allocation system, has significant potential as a second method for assigning costs. DSS allocates costs to VA healthcare products and to patient stays. Validity checks performed at HERC suggest that analysts should not rely exclusively on DSS cost estimates. Current results from the DSS validity analysis are found in a technical report (Phibbs et al., 2005).

Analysts turn to microcosting when average costing is unsatisfactory. For example, the average cost files developed by HERC cannot distinguish the costs of two patients in the same bedsection on the same day, or two patients who have a visit characterized with the same procedure code.[1] Microcosting is needed when an intervention changes patterns of resource use in a way that is not reflected by the Diagnosis Related Group, the bedsection, or the procedure code.

Microcosting is also needed to capture costs borne by the patient, such as out-of-pocket expenses, that are unavailable in VA administrative data systems. Microcosting is also one foundation of a broader method known as activity-based costing (ABC). In ABC, costs are organized by activity rather than by department or bedsection. Surveying staff members to learn their work patterns, an example of microcosting, is the first step in an ABC analysis (Brinker et al. 2000; Waters et al. 2001).

Microcost methods include three approaches: direct measurement, preparation of pseudo-bills, and estimation of a cost function. They are summarized below.

[1] A bedsection is similar to, but not exactly equivalent to, a traditional hospital ward.

1.2.1 Direct measurement

In direct measurement, inputs such as staff time and supply costs are directly measured to develop a precise cost estimate. The time of each type of staff is estimated and its cost determined from accounting data. The analyst may directly observe staff time, have staff keep diaries of their activities, or survey managers. The cost of supplies, equipment, and other expenses must also be determined. Program volume is determined from administrative records, and the average cost is then estimated. When units of service are not homogenous, unit costs may be estimated by an accounting approach, by applying estimates of the relative cost of each service, or via an econometric approach. Chapter 4 of this Handbook contains a detailed discussion of direct measurement.

1.2.2 Pseudo-bill

A second method combines VA utilization data with unit costs from non-VA sources to estimate the cost of patient care. This is commonly referred to as the pseudo-bill method because the itemized list of costs is analogous to a fee-for-service hospital bill. The unit cost of each item may be estimated from Medicare reimbursement rates, the charge rates of an affiliated university medical center, or other non-VA sources. The application of pseudo-bills to inpatient data is described in Chapter 5 of this handbook, and to outpatient data in Chapter 6.

1.2.3 Cost function

The third microcost method is the cost function, which consists of regression analysis of a cost-related outcome. Cost functions have several uses. At the level of individual patients they are used to estimate the cost of VA services and to determine the marginal increase in cost from a new intervention. At an industry level they can address problems like the optimal size of healthcare organizations and the timing of entry into and exit from healthcare markets. In our treatment of cost functions we will focus on patient-level applications.

A cost function is typically estimated with cost-adjusted charges as the dependent variable and information about the encounter as the independent variables. It requires detailed cost and utilization data for a specific, non-VA service. VA costs are then predicted using VA utilization data and the function's parameters. The chief advantage of this method is that it requires less data than is needed to prepare a pseudo-bill, making it more economical. The use of cost functions is explored in depth in Chapter 7 of this Handbook.

1.2.4 Distinguishing microcosting from average costing

It is useful at this point to clarify the distinction between average costing and microcosting. In average costing there is a predetermined, non-overlapping set of events (outpatient visits or inpatient stays) characterized by procedures, diagnosis codes, length of stay (for inpatient stays), and so on. One may think of them as alternative bins. Each event/bin has been assigned an average cost based on some other dataset. The study analyst's job is to match each observed event in the study with one of these predetermined bins. Sometimes the match between actual event and bin will be close, and other times it will not. By contrast, microcosting does not involve matching actual events to predetermined events/bins. Rather, the analyst determines the

total set of costly activities that occurred (procedures, inpatient days, nursing home stays, etc.) and then determines a cost for each. The sum of the component costs is the total cost for that event. Where the three methods of microcosting (direct observation, pseudo-billing, and cost functions) differ is in the way they determine the set of component events and their costs.

1.3 Types of Cost

The type of cost information needed will determine whether a microcosting approach is appropriate and will guide the choice between alternative microcost methods. In this section we start by distinguishing the concepts of cost, charge, and payment. We then address several issues that help to define the scope of cost data: study perspective, accounting versus economic costs, and long-run versus short-run time horizons.

1.3.1 Costs, charges, and payments

The concepts of costs, payments, and charges are sometimes used interchangeably in health services research. This is unfortunate, for they represent three distinct concepts. Moreover, understanding the differences among them will aid the researcher in preparing pseudo-bills for inpatient or outpatient utilization.

The three concepts are easily distinguished. The cost of a medical procedure is the sum total of all resources needed to carry it out. A charge for a medical procedure is the fee assigned by the provider for the service. The payment is the total reimbursement to the provider for the procedure by all payers.

The three concepts have differing uses in health services research. Costs are used to determine cost-outcome and cost-effectiveness ratios, typically from society's perspective. Charges are mostly useful for studies of the accounting practices of providers. Charges are not necessarily equal to any measure of cost, and usually charges exceed payments due to negotiated discounts between providers and payers. Payments are of greatest interest in cost-effectiveness studies done from the payers' perspective.

1.3.2 Accounting cost and economic cost

Definitions

Two concepts of cost are *accounting cost* and *economic cost*. Accounting cost refers to the purchase price of a good, including the cost of financing, minus depreciation. The accounting cost of a VA healthcare encounter is its cost as estimated by a cost allocation report. Accounting cost includes the direct cost of staff and supplies used, a share of the provider's overhead costs, such as administrative support, maintenance, utilities, and the amortized cost of equipment, buildings, and real estate. Costs are represented as the cash expended.

From a societal viewpoint, the full *economic cost* of a healthcare intervention is its *opportunity cost* (Garber et al., 1996). The opportunity cost of a good is the value of its next best alternative use. For example, a nursing home owned by VA could be rented out to a private nursing home operator. The opportunity cost of using it as a VA facility is the revenue it would generate as a

private facility. Likewise, a patient at a doctor appointment has foregone using the same time for work, hobbies, or other activities. The opportunity cost of the appointment is the value of the next-best alternative activity.

The distinction between accounting and economic costs can be important in cost-effectiveness analyses. Some items have economic value but no accounting value. A cost analysis from an accounting perspective would not count their value, whereas an analysis from a societal perspective would include their value.

Two healthcare items that have economic value but may not have accounting value are buildings and informally provided home healthcare. Because VA accounting rules fully depreciate all buildings over 40 years, buildings beyond that age have zero accounting value. They will continue to have economic value, however, as long as it has an alternative use that would generate revenue or that would save VA money it would otherwise have to spend. Healthcare provided by informal caregivers is similar. Although it has no accounting cost, it has a measurable economic value. In many instances, paid professionals must provide what is not available informally.

Measurement

Accounting cost at the level of department, services, or type of staff, is relatively straightforward to find using VA administrative databases. Chapter 3 of this handbook explains how one may calculate the accounting cost of VA staff using data from the Financial Management System (FMS). The average accounting cost of patient care by department can be found using the Cost Distribution Report, as described in Chapter 4. Chapter 9 explains how to determine the accounting cost of VA buildings and equipment.

The opportunity cost (economic cost) of real estate is straightforward to calculate. The opportunity cost of commercial buildings may be measured by the rental cost of similar buildings in the local market. Commercial real estate agents can provide estimates.

Measuring the opportunity cost of personal time is more difficult. Garber et al. (1996) note that the opportunity cost of time depends on its relation to other non-work ("leisure") activities. If patient values the time spent obtaining care equal to time spent on other leisure activities, then obtaining care has no opportunity cost. If the patient values it similar to work, then the opportunity cost of obtaining care is the lost wage. If the patient considers it to be worse than work, then the opportunity cost is greater than the wage. In practice, there is rarely information on patients' relative utility in leisure, work, and healthcare, and so the average hourly wage is typically assumed to measure the opportunity cost of time.

Personal wage rates cannot be used with confidence to value the time of people out of the labor force, such as retirees and some individuals with disabilities. A similar difficulty concerns the opportunity cost of time offered by informal caregivers. The Public Health Task Force raises these issues but does not offer a recommendation for dealing with them. One approach is to consider the importance of each of these factors in the total cost of the interventions being studied. If they are likely to constitute a significant fraction of costs, then the time value of such

care should be directly obtained through survey questions. Another option is to value the care according to a national average wage for in-home caregivers, as calculated each year by the U.S. Bureau of Labor Statistics. If such costs are likely to constitute only a small fraction of total costs, however, then it will most likely suffice to make a plausible assumption, with sensitivity analyses to determine whether the result depends on the particular values chosen.

1.3.3 Time horizon: short-run vs. long-run costs

When thinking about time, economists distinguish between the short-run and the long-run. The *short run* is a timeframe over which most costs are fixed. Hospital buildings, vehicles, real estate, and contracts often cannot be procured, eliminated or renegotiated over short period of time. In the short run, fixed costs may be ignored, as the cost of an intervention may be determined based on the variable elements. In the *long run* all economic elements may vary: buildings may be built, contracts negotiated, real estate bought and sold, and so forth. All costs are variable in the long run, and thus finding the total cost of the intervention requires assigning costs to every element.

The choice between short-run and long-run approaches should be guided in part by the scope of the intervention. If carrying out a new intervention as part of standard care would require building new facilities, then a long-run analysis should be done. A policy analysis of the federal end-stage renal disease payment program, for instance, would need to account for the outpatient dialysis clinics that sprang up due to the program and to the increased use of medical care by patients who have lived longer than they would have absent the program. Conversely, a short-run analysis (i.e., one that assumed that some costs are fixed) would be appropriate in managerial studies, where the analyst takes the perspective of the hospital and evaluates proposed changes that do not require capital improvements.

1.3.4 Perspective

The costs of healthcare are different from the viewpoint of patients and their families, employers, insurers, federal and state governments, and society as a whole. An example will illustrate. Suppose that it takes two hours for an employed person to obtain ambulatory care during a working day. To the patient, the time cost is the opportunity cost—the value of the next-best alternative use of that time. Employers will only value the patient's time if it is covered by sick leave or reduces the worker's productivity. Insurers would not value the patient's time under any circumstance, while society would always value it. A good discussion of alternative cost perspectives appears in Russell et al. (1996). Most authors have advocated the use of the societal perspective in cost-effectiveness and similar analyses, although not all (Garber, 2000).

1.4 Component Events of the Intervention

1.4.1 General considerations

Once an analyst has chosen a study perspective and time horizon, and whether to count the full economic costs of an intervention or simply the accounting cost, the next step is to determine which component costs of the intervention must be measured. There is a rule of thumb: to find the cost of an intervention, include the cost of all activities needed to replicate the intervention in

a typical healthcare setting. Costs incurred only to study the intervention should be excluded. When an activity involves both delivery of the intervention and research on its effect, the cost of any activity needed to deliver the intervention is included.

For example, consider the cost of a follow-up telephone call. The study participant is asked to return to a clinic to receive more intervention and to fill out a research assessment. The call is a cost of intervention. In order to replicate the intervention in the real world, the follow-up call will still be needed so that the patient will return to clinic to receive more intervention. A strict accounting of intervention cost would exclude any extra cost that was exclusively attributable to research—for example, any extra minutes spent describing the research assessment. This extra cost would not be needed to replicate the intervention in the real world.

Another example is a laboratory test conducted to identify patients who are eligible for the study. The test is a cost of the intervention because it would be needed to replicate the intervention elsewhere with same level of effectiveness.

Research and development (R&D) costs should be included if the study's purpose is to provide guidance on whether to produce the intervention at all. If the intervention already exists, then R&D costs should not be counted. For example, a study comparing the impacts of existing drugs would not take R&D costs into account. Once a drug is synthesized, the incremental cost to using it in a new setting is the cost VA pays to acquire it. If R&D costs are to be counted, they should be spread evenly over all future uses. A simple method is to divide R&D costs by the number of uses, based on reasonable forecasts of use and of the technology's expected lifetime.

There may be costs arising from subcontracts with outside firms. Contract costs should be included if they relate to the intervention. Beyond the stated value of a contract, there will also be indirect costs relating to the bidding process and contractor oversight. These indirect costs should also be included.

Clinical studies may involve a more intensive level of patient assessment than would occur under usual circumstances. For example, physicians may order more tests in a clinical study in order to detail patient outcomes as fully as possible in the final report. If the test is needed only to evaluate the intervention for research purposes, then it is a cost of research, not a cost of intervention. If test results affect subsequent care, then it becomes part of the cost of the intervention. By contrast, in general practice there is typically pressure to minimize costs by performing only those tests that are medically indicated. A knowledgeable clinician can determine whether the intervention is being carried out differently from how it would occur in typical practice settings. If so, a discussion of cost-effectiveness could present additional figures for the cost of the intervention under typical circumstances.

In some cases clinical staff members will perform tasks that relate both to an intervention and to normal patient care. Should time for these tasks be considered part of the cost of the intervention? From an economic theory standpoint, they should not. Only activities that would not have occurred absent the intervention should be counted as relating to the intervention. See the discussion of incremental costs in Chapter 5 for more detail.

1.4.2 Timing

The timing of data collection matters for several reasons. First, the average cost of the intervention may fall over time as clinicians become more practiced at performing it (Rosenheck, Neale and Frisman 1995). Second, clinicians differ in their efficiency. A study of care at a geriatric hospital, for example, should take into account that clinicians in other settings may not be as efficient in treating the elderly as those in a specialized facility. Finally, there may be returns to scale in providing an intervention as methods of care are adjusted within a facility. If this happens, long-run costs will fall below short-run costs measured during the study.

1.4.3 Staff time

Staff cost should be fully burdened with the cost of benefits, employer contributions to taxes, and non-productive time such as vacation and sick leave. This can be done in the calculation of the hourly cost of staff time. Total staff cost is divided by the number of applied (productive) hours, the time spent on activities that involve patient care. Hours on overhead activities such as vacations, sick leave, and professional training are excluded from the count of applied hours. Administrative duties and telephone calls that do not constitute patient care would also be excluded.

This method determines the hourly cost of a worker engaged in productive activities. Implicitly, the cost of vacation, sick leave and other "unproductive" activities is spread across the productive hours of the employee. For more details on measuring the cost of staff time, see Chapter 3 of this Handbook.

In addition to patient care and leave time, clinicians also engage in administrative duties, phone calls, and other activities. When determining the cost of an intervention, the researcher should consider whether any of these activities are taking place because of the intervention. If so, they may be excluded from applied hours and the cost would be distributed using this same method.

1.4.4 Double-counting costs

Garber et al. (1996) cautions against double-counting the patient's costs in a cost-effectiveness analysis. In particular, one should not count the same cost in the denominator (as a utility change) and in the numerator (as a loss in dollars). Consider a survey that measures patient utility following an intervention. If the survey refers to utility changes *holding income constant*, then the utility change may be assumed to refer only to pain and suffering. But if the survey does not instruct the patient to consider income (or productivity) fixed, then the analyst should assume that the utility change reflects those losses as well. In that case, the loss of income due to the intervention should not be counted separately in the numerator of the cost-effectiveness ratio.

1.5 Microcost versus Average-Cost Methods

Microcost and average-cost methods are not mutually exclusive. In fact, it is often appropriate to use mixed methodologies in the same study. Typically a microcost method for estimating the cost of care associated with an intervention is combined with an average-cost method for finding the cost of other, unrelated care. Of the three microcost methods, the most appropriate choice for

a particular study will depend on the level of accuracy required and the levels of resources available. Microcosting methods can be highly accurate but expensive to employ. Average-cost methods require less effort but yield cost estimates that may not fully reflect how an intervention affects the resources used in providing care.

The average-cost method is limited by the set of assumptions used to create the averages. When deciding on the optimal method, analysts should consider whether the assumptions are appropriate to utilization data in the study. For example, will the intervention affect the cost of hospitals stays in a way that will not be captured by the DRG or length of stay? Will it affect the cost of ambulatory visits in a way that will not be captured by the relative value units associated with CPT codes? If either of these is true, then average costing may be inappropriate. HERC staff can offer assistance in determining the appropriateness of average-cost methods for particular studies.

Microcosting has limitations as well. The encounter-level claims in the Medical SAS® files, the traditional VA source of national utilization data, do not include drug prescriptions. Prescription data must be obtained from other sources such as the proposed DSS Pharmacy Extract or from the Pharmacy Benefits Management database. It is uncertain if the Medical SAS files include all outpatient care, particularly laboratory tests and prosthetic supplies. If these are underreported, then researchers who need to estimate this type of utilization must turn to microcosting. Some outpatient laboratory tests may be lacking from the Medical SAS files. Gaps may be filled from a review of patient records, from the proposed DSS national laboratory extract, or from the VistA system (Hynes et al. 2002). Similarly, data on prosthetics services kept in the National Prosthetics Patient Database may not be reliably reported in the main inpatient and outpatient utilization datasets.

2. VA Cost Datasets

2.1 Introduction

Chapter 1 reviewed the issues to consider when choosing between microcosting and other costing methods. To perform microcosting, the analyst must be able to assign costs to elements of the intervention. This chapter gives an overview of the primary databases used to determine the costs of VA care. These include the VA general ledger (FMS), department-level cost files, inpatient and outpatient utilization files (Medical SAS files), the Decision Support System National Data Extracts (DSS NDE), and the Pharmacy Benefits Management Version 3.0 (PBM V3.0) database. Brief mention is made of additional sources for assigning costs to physical assets and care provided at non-VA facilities.

Each data source identifies costs by time period and facility. Facilities are identified by a three-digit station number. In some cases, subdivisions of a facility may be identified through a five-digit code that consists of the three-digit station ID followed by two additional digits. For example, the VA Palo Alto Healthcare System has the station ID '640.' This number applies to all of its divisions, including Palo Alto, Menlo Park, and Livermore. VA could choose to distinguish between the divisions by using a five-digit ID, such as '640A0 for Menlo Park, and '640A4' for Livermore. Leaving the extra two digits blank designates the parent station, Palo Alto. Five-digit IDs do not exist at every facility and may change over time. As a result, particular care must be exercised in relying on five-digit IDs to distinguish divisions of a single facility. The VA Planning System Support Group maintains an updated list of facilities and their corresponding codes.

In the sections that follow, information is presented by topic:

- Structure and contents
- Use in health research
- Guidelines and programs
- References

Structure and contents describes the structure of the dataset, the variables it contains, the population it covers, and its sources. How the dataset is typically used for economic research is covered in *Use in health research*. In *Guidelines and programs* we describe where to obtain documentation and example programs. We will also note whether instructional materials are available in printed or electronic format. The *References* section will note published studies that have used the respective data sources to estimate VA costs.

2.1.1 Access

FMS and DSS datasets are stored at the VA Austin Information Technology Center. Access to them is gained through a time-share account. Currently these accounts are available only to employees of federal agencies. For VA employees, the request to establish an account is made through the local Information Security Officer (ISO). When establishing an account the user

must request access to particular datasets, identified by name and functional task code (FTC). The list of available datasets and corresponding task codes is available from the ISO. Each use of the account accrues a charge. Quarterly billing statements are sent to the user's VA facility administration rather than directly to the user.

PBM V3.0 is created and stored by the PBM Strategic Healthcare Group at the Hines VA Medical Center (Hines, IL). Data extracts are created for users by the PBM staff; direct access to the data is not permitted. In general there is no charge for pilot studies by VA researchers. Charges may apply to funded studies and to non-VA users.

2.2 Financial Management System (FMS)

2.2.1 Structure and contents

The Financial Management System (FMS) is the electronic general ledger for the VA. Its purpose is to track obligations and expenditures by month, quarter and fiscal year. The data are organized according to the following characteristics:

- Month and fiscal year
- VA station
- Cost Center
- Budget Object Code

There is a separate file for each federal fiscal year, which runs from Oct 1st to the following Sept. 30th. Although FMS is updated monthly, researchers should use only the September files. The September file contains all data for the previous fiscal year. Researchers may obtain a skewed view of costs by using data on partial fiscal years. This is because supply and equipment expenses are higher at the end of the fiscal year, and because partial year reports do not include end-of-year adjustments and reconciliations.

FMS data are reported at the station level, identified by the three-digit variable STA3N. The stations frequently include multiple facilities in a single geographic area. In some cases an additional two-digit code is available to identify data pertaining to the division, the individual location within a station.

Expenditures are further categorized into Cost Centers and Budget Object Codes.[2] A cost center is a VA service, such as the Psychiatry Service, the Nursing Service, and the Chaplain Service. Cost centers are not equivalent to patient care departments. A single service may include people who work in several patient care departments and administrative offices. The Budget Object Code, often called the *sub-account*, identifies the type of expense. Examples include personnel, medical supplies, and some capital. Large capital purchases are accounted for the in VA capital databases, described in Chapter 8.

[2] Information on expenditures in this guidebook applies to obligations also.

2.2.2 Use in health research

FMS has several potential uses in cost analyses. It can provide average annual costs of employing personnel in more than 70 job categories, making it a necessary tool for determining costs in some VA clinical trials. Selected supply and capital costs can be determined as well. Using files from multiple years, a researcher can track changes over time in expenditures across VA divisions, VISNs, or other administrative categories.

2.2.3 Guidelines and programs

The original guide to using FMS was Volume IV, Chapter III of the VA Database Resource Guide, also called the "Blue Books," available on the HERC web site. While outdated in parts, the volume provides a good explanation of the relation of FMS to its predecessor, CALM.

HERC has prepared a separate guidebook on FMS. It features file layouts and variable descriptions for the two files of most interest to VA researchers. An earlier version of the guidebook constituted a chapter of the 2005 edition of the HERC microcost guidebook.

2.2.4 References

The development in the late 1990s of the DSS national data extracts and the HERC Average Cost Data eliminated the need for researchers to use FMS data directly. The data comprise a key component of DSS costs, however, and so play a vital background role. FMS data are also used to estimate average labor costs for more than 70 job categories. HERC Technical Report #25 (Smith and Cheng 2010) explains how to use FMS data for this purpose. The method was applied in Barnett and Swindle (1997). The authors employed CALM, the predecessor of FMS, to estimate the staffing cost of inpatient substance abuse treatment programs in 1990. The authors used two methods of estimating total treatment costs: one that combined staff effort from a survey and CALM estimates of salary costs, and a second based on costs reported in the databases with cost by department or category of care, the VA cost allocation report described in the following section. Their results were not sensitive to the source of cost data.

2.3 Cost Distribution Report and Monthly Program Cost Report

2.3.1 Structure and contents

Prior to the development of the Decision Support System (DSS), VA relied on report RCS 10-0141, also called the Cost Distribution Report (CDR), to estimate costs at the department level or by category of care. CDR was phased out in FY2004 and replaced by the Monthly Program Cost Report (MPCR). Both represent a reallocation of the expenditures reported in FMS. They differ in the source of staff time and in the data used to distribute costs and staff time to Cost Distribution Accounts (CDAs). An earlier analysis of MPCR revealed that, unlike CDR, it does not reconcile to end-of-fiscal-year spending figures. As a result it cannot be recommended for research use. For details of MPCR, see the HERC guidebook by Wagner and others (2006).

There are two additional sources of cost organized by department or category of care. One is the Account Level Budgeter Cost Center (ALBCC) data within DSS, which have been created since

FY1999. The data reflect the relative value units (RVUs) built into the DSS system. A second is an annual tabulation of HERC Average Cost Data by station and category of care. These data use the average-costing methods detailed in Wagner and Barnett (2009) and Phibbs et al. (2008) and reflect Medicare RVUs rather than those of DSS. The HERC station-level data are available from FY2000. They are described in detail in a guidebook on the HERC web site (Wagner 2009).

2.3.2 References

Databases with cost by department or category of care have been employed in many studies of VA care. As noted earlier, Barnett and Swindle (1997) used CDR to estimate the cost of inpatient substance abuse treatment. Among other studies are Kominski et al. (2001), Rosenheck et al. (2003), and Sernyak et al. (2005) for mental healthcare, Fortney et al. (2005) on primary care versus specialty and inpatient services, Hughes et al. (2000) for home-based primary care, and Wagner and Chen (2005) on residential treatment. In a different vein, Carey (2000) used 1997 CDR data to illustrate a multilevel technique for modeling patient costs.

2.4 Medical SAS® Files

2.4.1 Structure and contents

VA researchers often need to know how patients use medical services and procedures. The national VA computer center, the Austin Information Technology Center (AITC) makes available two primary sets of files containing utilization data: the Medical SAS Inpatient Databases for hospital stays and the Medical SAS Outpatient Datasets for ambulatory services.[3] Table 1 and Table 2 (following page) list the files within each of these and highlight some of their pertinent features.

2.4.2 Use in health research

The Veterans Health Administration exists to offer healthcare, and the utilization files are the records of VA's efforts. The files are used for many purposes. In the planning stage of a health services study or clinical trial, the data can reveal the number of potential patients meeting specific diagnosis and/or procedure criteria. Utilization records have been used to study standards of care within the VA system. They also reveal the impact of administrative efforts to reach subpopulations such as women, people with posttraumatic stress disorder, or veterans of the Vietnam era.

[3] Earlier names for these files include the Patient Treatment File (PTF) and the Outpatient Care File (OPC). The Medical SAS files are derived from the National Patient Care Database (NPCD), and that name is sometimes used as well.

Table 1: Characteristics of Medical SAS® Outpatient Databases

File Name	First Year	Final Year	Record Unit	Special Features
SF: Visit File	FY1980	(continuing)	one day	Demographic data
SE: Event File	FY1999	(continuing)	one encounter	Procedures, diagnosis code, and types of providers; supplanted SC and SG files in 2002.
SC: Procedure File	FY1990	FY2001	one encounter	CPT procedure codes[1]
SG: Diagnosis File	FY1997	FY2002	one encounter	ICD-9 diagnosis codes

[1] Covered only surgical clinics prior to FY1996.

Table 2: Characteristics of Medical SAS® Inpatient Databases

	File Name Suffix			Record Unit	First Year
	Acute Care Data	Extended Care Data	Observation Data		
Main File	PM	XM	PMO	one discharge	FY1970
Treating Specialty File*	PB	XB	PBO	one bedsection admission	FY1991
Procedure File	PP	XP	--	one discharge	FY1988
Surgery File	PS	XS	--	one discharge	FY1984

* The terms bedsection and treating specialty represent the same classification system.

2.4.3 Guidelines and programs

The Veterans Affairs Information Resource Center (VIReC) has produced detailed guides to the utilization files. For each file the guides specify the variable names, file layouts, and file names. They are available in PDF format on the VIReC web site (www.VIReC.research. va.gov).

2.4.4 References

The Medical SAS files have long been the primary source of data on VA utilization. Recent publications on specific conditions have used them to evaluate screening for military sexual trauma (Kimerling et al. 2008), psychiatric monitoring among people at high risk of suicide (Valenstein et al. 2009), and geriatric evaluation and management (GEM) units (Phibbs et al. 2006). The datasets also get wide use for general health services analyses on topics such as intensity of end-of-life care (Richardson et al. 2007), cross-system service use (Desai et al. 2001), the relation of race and ethnicity in VA healthcare (Collins et al. 2002; Dominitz et al. 2002), and case-mix adjustment methods (Sales et al. 2003).

2.5 Decision Support System National Data Extract

2.5.1 Structure and contents

The Decision Support System (DSS) is a set of software and hardware products designed to store and analyze healthcare utilization and cost. Each VA medical center implemented DSS separately, with system-wide implementation achieved in FY 1999. Researchers may use DSS data to investigate inpatient and outpatient care, including prescription-drug use.

The Decision Support Organization (DSO) has created a series of extracts that combine data from the DSS system at each VA station. To find a current list of these National Data Extracts (NDEs), visit the VIReC web site (www.VIReC.research.va.gov) and search under Decision Support System (DSS). The datasets fall into several broad categories: encounter-level NDEs with cost estimates; clinical data from laboratory, pharmacy, and radiology, some with costs; financial files that feature data by year, station, and category of care; and a miscellaneous group. The core NDEs feature data from FY1999 to the present, but others began more recently. Consult the VIReC web site for data availability.

2.5.2 Use in health research

Like the Medical SAS files, the DSS NDE extracts may be used to determine utilization of VA services. Unlike the Medical SAS files, the DSS NDE also includes cost data. Direct and indirect costs are presented separately, allowing users to choose based on their needs.

As documented in Phibbs, Yu and Barnett (2005), the correspondence between the Medical SAS files and the DSS NDE inpatient and outpatient files is not exact. DSS and the Medical SAS files report agree on the number and length of hospital stays, but there is discord with respect to the number of days spent in different wards (bedsections). Visits assigned a cost between $-1.00 and $1.00, or no cost at all, appear in a separate “low-cost” file rather than the core DSS outpatient NDE. DSS files have information on care that is not included in the Medical SAS files, such as the total cost of all prescription drugs dispensed to outpatients on a given day. Researchers are welcome to contact HERC for guidance on choosing the most appropriate data source.

2.5.3 Access

DSS NDE data may be accessed through time-share accounts at the Austin Information Technology Center. As with the traditional OPC and PTF utilization data, one may access data with either scrambled or true social security numbers. It is straightforward to obtain access to DSS data with scrambled SSNs (variable SCRSSN). Obtaining access to DSS data with real SSNs is more difficult, requiring a project-based justification and signatures from the local medical center director and officials in Washington.

A number of DSS “data cubes” can be accessed using the ProClarity software application. Summary reports are available on the web. The cubes represent a new way of viewing VHA data. As in the KLFMenu, the viewer specifies several parameters (such as location and time period) and then requests summary figures. The calculations occur in real time and results are

presented in spreadsheet format. The cubes feature only summary information at the nation, VISN, or medical-center level. Person-level data are not accessible to most viewers.

DSS data cubes can be accessed through the KLFMenu (www.klfmenu.med.va.gov). After reaching the site, search for DSS under "finance." ProClarity software must be installed on your PC in order to view the data cubes.

2.5.4 Guidelines and programs

There are several sources of information on DSS data. HERC has prepared a technical report on the use of the DSS NDE (Yu and Barnett 2003) as well as a separate guidebook comparing the encounter-level inpatient and outpatient NDEs to the NPCD (outpatient) and PTF (inpatient) utilization datasets (Phibbs, et al. 2008). The guidebook and technical report are available on the HERC intranet web site and by request.

The VIReC web site features a document that explains the goals of the DSS system and the differences between the local and national extracts (http://www.VIReC.research.va.gov/DataSourcesName/DSS/DSSintro.htm). It also briefly describes DSS production data, a series of datasets containing a much greater level of detail on the constituent costs of an encounter. Although detailed production data reside at the Austin Information Technology Center, at this writing access to DSS production data requires permission from each individual facility from which data are desired.

2.5.5 References

DSS data are employed in a variety of health economics and health services studies each year. For example, Barnett et al. (2002) studied the cost-effectiveness analysis of selective coronary angiography and revascularization after myocardial infarction. Maciejewski et al. (2002) assessed the performance of community-based outpatient clinics (CBOCs). Lum (2002) used DSS to study urinalysis for illegal drugs. DSS cost data were employed by Sales et al. (2003) to test the predictive capability of a pharmacy-based risk-adjustment model. McGinnis et al. (2009) compared DSS data to that of the VA Immunology Case Registry. Similarly, Chapko et al. (2009) compared costs from the DSS system to those in the HERC Average Cost Datasets described later in this guidebook.

2.6 Pharmacy Benefits Management (PBM) V3.0 Database

2.6.1 Structure and contents

The Pharmacy Benefits Management Database Version 3.0 (PBM V3.0) contains information on each outpatient prescription filled by VA. Its primary sources are monthly data submissions from more than 140 VA pharmacies. The PBM Strategic Healthcare Group (SHG) cleans the submitted data and creates additional variables. The final data are stored in database format, rather than the SAS file format typical of data stored at AITC. Data are available for FY 2002 for all VA facilities, and for earlier years at select facilities.

The database includes many characteristics of the prescription, such as fill date, quantity dispensed, dispensing unit, days supplied, and direct cost. An unusual feature is the presence of dosing instructions. The National Drug Code (NDC), VA product name, and VA drug class identify the medication. For generic agents there may be a single NDC assigned to identical formulations supplied by two or more manufacturers. This is unlikely to cause substantial trouble for researchers, however, because branded medications account for the lion's share of spending. For additional detail on the contents of PBM V3.0, see Smith and Joseph (2003) and the VIReC web site (www.VIReC.research.va.gov/DataSourcesName/PBM/PBM.htm).

Several expansions to the PBM database are also planned. Although currently only outpatient data are available, a database of inpatient prescriptions is under construction. PBM SHG also expects to release an updated Version 4.0 system soon. The system will provide a wider range of data elements than does Version 3.0.

2.6.2 Use in health research

The PBM V3.0 database is suitable for determining the direct cost of medications dispensed by VA. It does not include any overhead charges or dispensing fees, and so total cost cannot be determined. The data can be used to assess prescribing practices across facilities, conditions or time.

The method of assigning costs to prescriptions deserves a brief explanation. The primary mission of the PBM SHG is to administer the VA National Formulary process. One aspect of its work is the negotiation of prices for prescription medications. PBM SHG then creates a contract cost file listing the negotiated price of every medication for which a contract exists. In theory each VA pharmacy consults the most recent price file when assigning a cost to dispensed medications. It is clear from the data they submit, however, that not all pharmacies do so. As a result two pharmacies may assign different costs to identical prescriptions on the same day. Moreover, local pharmacies are not bound to purchase drugs through the formulary system. They have the ability to procure them at market prices as well, and in a few cases this occurs.

One strategy for avoiding these price irregularities is to rely on the contract cost file rather than on the actual costs assigned. Although the contact cost file is updated daily, PBM SHG has maintained an historical file for several years that records each change of contract price for every medication in the National Formulary Process. The historical file is available from the PBM SHG on request.

Access to the PBM V3.0 database is unlike that of other VA databases. All requests to PBM SHG must be accompanied by a research protocol that explains the planned uses of the data. In order to avoid conflicts with its primary mission, PBM SHG does not permit use of PBM V3.0 data for studies whose design appears to favor one or another medication. There is also a fee for data extracts, except those for unfunded VA pilot studies or VA management projects. The fee will depend on the amount of effort needed to create the extract and the time needed, if any, to consult on study design. Potential users of PBM V3.0 should contact PBM SHG staff in advance to learn about current policies.

2.6.3 Guidelines and programs

There is no printed guidebook for using PBM data. The best source for information on the construction of the V3.0 database is the PBM Strategic Healthcare Group. Telephone and address information may be found on its internet site, www.vapbm.org. The VIReC web site features a database dictionary and explanatory essay. A comparison of data in the PBM V3.0 and the DSS Pharmacy Extract appears in Arnold (2008). Because new data fields are added to the DSS Pharmacy Extract over time, researchers contemplating use of the DSS Pharmacy Extract should contact VIReC or the DSS Bedford Technical Services Office for the latest information.

2.6.4 References

PBM data have been used in many published studies. Rosenheck et al. (2001) and Leslie and Rosenheck (2001) analyzed the use of antipsychotic medications. PBM pharmacy data and other VA data sources were used by Render et al. (2003) to estimate the cost of providing the VHA pharmacy benefit outside of the VA system. Yu et al. (2006) employed PBM data to study the cost of health care for persons with schizophrenia.

HERC has compared the purchase price field in the PBM data to the DSS variable supply cost (VS_Cost) for a cohort of individuals enrolled in a clinical trial (Smith and King 2007). The authors found that the PBM price and the DSS variable supply cost differ by less than $0.80 per outpatient prescription on average, but there was considerable variance in the difference across a large number of prescriptions.

2.7 Other Datasets

2.7.1 Allocation Resource Center files

The VA Allocation Resource Center has created files that estimate the cost of health incurred by individual patients. These data represent a measure of workload that is used in the VA budget allocation process. Prior to FY2002, these cost estimates were based on the CDR; cost estimates are now based on DSS data, but the methods used have not been documented. The Allocation Resource Center files stored at AITC do not report the cost of individual healthcare encounters.

2.7.2 Fee Basis Files

The Fee Basis Files report the cost of care provided under contract to VA. There are separate files for inpatient stays, inpatient ancillary services and physician charges, outpatient care, pharmacy, and travel payments. Two additional files list monthly payments to individual pharmacy vendors and other vendors. An eighth file shows payments made on behalf of veterans who received regular outpatient Fee Basis care through the ‘Fee Card’ program. While there is some information characterizing hospital stays (in the Non-VA PTF file) little information is available on other types of healthcare reported in these files. Care provided through sharing agreements with affiliate universities does not appear in Fee Basis files, although some care purchased from Department of Defense facilities does appear. (For more information on sharing agreements, visit the HERC web site and follow the link to Resources and then to FAQ I17.)

Fee Basis files for FY1987 through the current fiscal year are stored at AITC. The data are stored in raw text format. Summary Fee Basis expenditure data are also available on a data cube within the Financial and Clinical Data Mart (FCDM). Visit the KLFMenu and then search for non-VA care.

HERC has prepared a guidebook on using the Fee Basis data for research. It presents the contents of each file and all formatted values for selected variables. The guidebook describes construction of the files and offers recommendations on how to combine it with other VA datasets. An accompanying technical report shows summary cost and utilization figures for selected years. The documents are available on the HERC intranet web site or by request. There is also a FAQ response about Fee Basis data on the HERC web site.

2.7.3 Fixed Asset Package

The Fixed Asset Package tells the acquisition cost, useful life, depreciation, and undepreciated balance of all VA capital assets. The files are stored at AITC. A guidebook for understanding Fixed Asset Package reports is available on the intranet site of the VA Allocation Resource Center. A link to the page is also available from the HERC intranet site.

2.7.4 Database of VA facilities

The Veteran Administration Site Tracking system (VAST) provides the location and characteristics of VA facilities and contract providers. The VA Planning Systems Support Group (PSSG) in Gainesville, FL, creates this file. PSSG has a web site on the VA internal network.

2.7.5 PAID

The PAID system contains information on VA payroll, training and credentials, and other matters. It is the only source of salary and benefit costs at the individual level. For registered nurses PAID indicates the ward (bedsection) where the nurse is assigned. The data have been used to study the relation of nurse staffing and seniority on outcomes of care, and to analyze the link between research funding and physician retention.

PAID data are highly confidential and may not be accessed directly by researchers. To obtain an extract, one must submit a request to the proper authority with a description of the research project and proof of IRB approval. HERC has prepared a guidebook that explains the contents of the PAID dataset and offers suggestions for its use by researchers. The guidebook may be downloaded from the HERC intranet web site or requested by email (herc@va.gov).

2.76 NPPD

When a prosthetic item is ordered, the order appears in the “prosthetics package” within VistA. Extracts from every VistA system are merged to form a national dataset, the National Prosthetic Patient Database (NPPD). Each item dispensed has a separate record, and thus a single encounter could produce multiple NPPD records. Prosthetic items are identified by a five-digit HCPCS code. Most records contain an ICD-9 diagnosis code for the condition that necessitated the prosthetic.

In VA the term "prosthetic" is defined broadly. It includes artificial limbs, sensory aids, durable medical equipment, external fixation devices, and all manner of implanted items, including cardiac stents and catheters. NPPD is therefore a potentially rich source of data on patient treatment. There is, however, a significant obstacle to using NPPD for health services research: NPPD does not record the service date, the day when the patient received an item. Rather, it records only the date on which the prosthetic item was added to the VistA prosthetics package. The data entry date and the service date can be weeks or even months apart, making it difficult to match prosthetic items to narrow time periods or fix it within a particular chain of health care events.

The NPPD cost field for a new item is its purchase price. It does not include labor or overhead (indirect) costs. Many prosthetics are purchased on contract, in some cases local or regional and in other cases national. A small proportion of items are purchased off-contract, typically those with unusual and specialized features.

One field in NPPD indicates whether the item was new or used. The cost assigned to used items is 50% of the cost of a new item of the same type. This is an arbitrary estimate that should not be used without due consideration. An alternative method for pricing used items is to use the Medicare RVU assigned to used items. For example, suppose that the RVU for used and new wheelchairs of a particular type were 18.569 and 26.354 RVUs, respectively. The ratio of used to new RVUs is .705. If the average price in NPPD for a new wheelchair of this kind were $1,000, one could assign a cost of $705 (= .705 * $1,000) to the used item.

There are several published sources that provide details and insight on NPPD. Pape et al. published a brief data dictionary in 2001. (Note that the definition it provides for "DELIVERY DATE" does not clarify that this is not the service date.) Render et al. (2003) employed NPPD in a study comparing VA and Medicare payments for assistive devices. After comparing NPPD records to results of a micro-study of patients at selected VA sites, Nugent et al. (2004) concluded that NPPD undercounts durable medical equipment. This is consistent with findings by HERC researchers that many prosthetics-related procedures in OPC/PTF and DSS NDEs do not have matching prosthetics records in NPPD. HERC has prepared a technical report on the NPPD (Smith, Phibbs and Su, 2007). The report appears on the HERC intranet web site. A journal article based on the report is scheduled for publication in 2010.

2.8 Department-level cost databases

There are three databases on patient care expenditures by VA medical center that include detail by type of care. The VA department level cost database is called the Account Level Budgeter Cost Center (ALBCC). VA also creates a Monthly Program Cost Report (MPCR). A third DSS based dataset, the station-level cost database, was developed by HERC. The differences between these data sources are provided in Table 3. Each of these databases is documented by a separate HERC guidebook.

Table 3: Characteristics of Department-Level Cost Databases

	Account Level Budgeter Cost Center	*Monthly Program Cost Report*	*HERC Station-Level Cost Dataset*
Definition of cost category	Production Units that correspond to actual organization of medical center	Categories of patient care based on location where care was received (including cost of ancillary services).	Categories of patient care based on location where care was received (including cost of ancillary services)
Costs included	All costs reported in FMS	Funds disbursed via the VERA budget system	All costs reported in DSS national data extracts
Corporate overhead and depreciation	Included	Excluded	Included
Budget object code	Available	Not available	Not available
Cost center	Available	Not available	Not available
Method of assignment	DSS mapping of personnel, supply, and other expenses	Distribution among categories in previous period	Tabulation of cost of stays and visits in DSS national data extracts
First year of data	2001	2004	2000

The ALBCC includes all expenditures made by VA, including facility and equipment depreciation as well as corporate overhead. This overhead includes the cost of the VA central office and other centers that provide patient care services, such as the VA mail out pharmacy. ALBCC provides cost data for each production unit in the medical center, defined by a two digit code identifying the location of care. The cost of caring for inpatients on the medical service is reported not only in the costs of the production unit for the ward where care was provided, but also in the laboratory and pharmacy departments that provided ancillary services used in those stays.

The detail in the ALBCC can be useful for micro-costing. It reports cost in each production unit, information that is not available in FMS. While FMS would provide information the cost of employing full time physicians (budget object code 1081) at a particular medical center, ALBCC provides detail on the cost of employing full-time physicians within a particular production unit, e.g., psychiatry clinic.

ALBCC also provides information on the overhead (also called indirect costs) that has been distributed to patient care departments. The cost analyst may have information on the direct cost

of an intervention obtained by direct measurement (see Chapter 5), and need to estimate the associated indirect costs. An example of how ALBCC data have been used to estimate indirect costs can be found in HERC Technical Reports 5 and 6 (Barnett and Berger 2003a, 2003b).

Both the MPCR and HERC station level datasets provide the cost of different categories of patient care at each VA medical center. Both datasets tabulate the cost of patient care based on the location where it was received. These reports provide information on the cost of inpatient general medical care, including the cost of ancillary services such as laboratory and radiology services used by patients on that ward. There is no separate estimate of laboratory or radiology departments in these databases. Both datasets lack cost center and budget object code information, so that it is not possible to find the types of expenses that were spent within each category of care, for example, what was spent on physician or nurse salaries.

MPCR is a database with a very specialized purpose, needed by VA managers but unlikely to meet research needs. MPCR reports only on funds distributed through the VA Veterans Equitable Resource Allocation (VERA) system. As a result MPCR does not include the cost of depreciation and corporate overhead. Designed with an emphasis on timeliness, the cost figures in MPCR do not reconcile to the final end-of-year cost estimates in DSS. The following chapter provides a brief overview of MPCR.

The HERC station level data set is a tabulation of the DSS inpatient and outpatient national data extracts. Costs are assigned to 25 categories. The 12 inpatient categories are based on the VA treating specialty, a two digit code representing the type of care. (The terms treating specialty and bedsection can be used interchangeably, although since FY2008 the alphanumeric codes used to represent them in VA datasets do not always match.) The 13 outpatient categories are defined by the VA clinic stop, a three digit code representing the type of outpatient care. The HERC categories are similar to those used in both MPCR and CDR.

The HERC station level cost database can be used to analyze trends in VA cost for a particular type of care. It can also be used to estimate the mean cost per visit, per discharge, or per day of stay for a particular type of care.

3. The Cost Distribution Report and the Monthly Program Cost Report

The Cost Distribution Report (CDR) documented the use of the VA Medical Care appropriation. It contained estimates of the expenditures for patient care and support departments at each VA medical center. For many years it was the only comprehensive source of historical information on patient care services funded by VA. CDR, sometimes referred to as report RCS 10-0141, was based in part on workload data from service chief estimates. After FY2004 it was replaced by the Monthly Program Cost Report (MPCR), which draws staff activity data from the Decision Support System (DSS).

CDR was employed to find VA expenditures by program and to find the average cost of healthcare, such as the average cost of a day in a long-term care unit or the average cost per outpatient psychiatric visit. There is now little need to consult CDR data for research. DSS has provided reliable data on workload and costs since FY2001 at every station and since the 1990s at selected stations. Although MPCR has many features in common with CDR, it should not be used for research projects. MPCR is not reconciled to end-of-year spending figures and thus cannot be used to determine total or average costs.

Considerable information is available about CDR and MPCR. An overview appears in the previous version of this guidebook dated December, 2005, available on request from HERC. The strengths and limitations of CDR for cost research were described in Swindle et al. (1996), Barnett (1999), and Menke et al. (1999). MPCR was documented in a HERC guidebook by Wagner and others (2006).

4. Direct Measurement of Costs

A challenging element of cost-effectiveness analysis is the proper measurement of costs. While frequently costs incurred by patients in VA-sponsored studies can be determined through HERC Average Cost estimates, DSS, non-VA data systems, or published clinical studies, in some cases these will not provide enough information. Summary administrative data cannot identify an individual person or intervention, and there may be no published studies of the cost of new interventions or those unique to the VA. In some cases, administrative data exist but do not correspond to the study perspective. When existing sources are insufficient, researchers can gather data through surveys and personal observation. This is called *direct measurement*. Common methods of direct measurement include the following:

- A rater observes staff members or patients to determine how much time is spent on the intervention
- A staff member fills out a log of activities relating to the intervention
- A patient completes a survey about time spent for direct care, transportation, and unpaid care at home
- A supervisor fills out survey, estimating the number of hours spent on the intervention by each type of staff member (nurse, physician, social worker, etc.).

This chapter describes how to use direct measurement to estimate the cost of an intervention.

Researchers may use direct measurement alone or in combination with other methods. In some cases direct measurement will be the only available source of information on an intervention, as when the intervention is new or unique to the VA. Researchers may use direct measurement to find the cost of a new or unique intervention, while using a less precise method like average costing for all other care. Since microcosting requires many research resources, its use is limited to the parts of the study where a high level of precision is needed.

4.1 Three Methods for Measuring Activities

This section describes common methods of direct measurement. These include traditional time-and-motion studies, in which someone observes the process of care; activity logs, in which providers monitor their own time; and surveys of managers and patients. Each of these methods may be used alone or in combination to measure provider and patient activities. Examples of these activities include medical procedures, physical therapy, psychotherapy, and training.

4.1.1 Time-and-Motion Study

In this approach, the analyst directly observes the staff members and keeps track of the time spent on each activity throughout the day. Observing staff members may yield very precise results but is costly because observers must be paid for their time both in training and in data collection.

4.1.2 Activity Logs

A second approach is to have employees keep daily activity logs for a sample of survey dates. The staff members record activities during each 30-minute interval of work (or 15-minute, 10-minute, etc.) and characterize whether the activities involve the intervention being studied, or some other activity. Accuracy can be nearly as good as with time-and-motion studies. Time logs carry additional administrative burdens as well: developing and pre-testing the survey instrument with allowance for staff members' input, training staff members to use the logs, and following up to ensure that logs are completed and gathered. It may be necessary to survey program managers beforehand to learn which staff members will need to complete logs.

It may not be necessary to use activity logs for every day of an intervention, particularly if it extends for weeks or months. A random sample of days will suffice, or a random sample of hours within a day, but the sampling frame must be designed with care. If an intervention becomes less intensive over time, for instance, basing an estimate on activity logs from the early days of the intervention would lead to an overestimate of total time spent.

4.1.3 Manager Survey

A third method for gathering staff data is to survey managers. The surveys can collect two types of information: the number of full-time-equivalent employees involved in the intervention, and the number of hours spent on the intervention per day or per week. In order to calculate staff compensation costs accurately, separate responses should be obtained for each category of employee involved: registered nurses, physicians, lab technicians, and so on. Finer detail may be needed if experienced or specially trained providers predominate, as in a geriatric care unit.

Manager surveys are common because they take less time to prepare or complete. A single manager can report on activities of many staff members, and so another advantage is the relatively small number of people who must be surveyed. The primary drawback of manager surveys is a relative lack of accuracy and precision. Managers may have a good sense of the number of days spent on the intervention in a week, for example, but probably will not be accurate at the level of hours or half-hours. The quality of data from manager surveys depends on the effort of the mangers themselves. Manager surveys are not advisable when high precision is needed or when many managers would have to be surveyed to cover the actions of all staff members involved.

4.1.4 Combining Methods

It is often advisable to use two or more methods in the same study to save money while obtaining an acceptable level of precision and accuracy. Consider a study comparing surgical and drug treatment. An analyst might use staff surveys or study logs to determine the cost of the initial treatment. A less precise but less costly method such as average costing could be employed to determine the cost of subsequent healthcare.

4.2 Considerations in Designing a Cost Analysis

4.2.1 Aggregation Level

The costs of an intervention may be analyzed at many different levels: the cost per intervention, per clinic visit or hospital stay, per patient contact, per day, etc. The aggregation level will guide the choice of data collection methods. Both the methods and the aggregation level will affect the overall reliability and external validity of the results.

The choice of analysis level should be guided by the feasibility of the data collection that would be necessary. There are two basic elements to consider: the *ability* to observe the data with accuracy and precision; and the *cost* of collecting data. For example, cognitive impairment may prevent patients from completing self-reports accurately (without bias) or precisely (with sufficient detail). But self-reports may be necessary to track at-home care because sending a third party to scores of patient homes could be prohibitively costly. A data collection method would also be infeasible if many potential patients find it intrusive and refuse consent.

The aggregation level should also match the clinical endpoints. For example, it would be natural to estimate per visit cost for an intervention intended to reduce the number of outpatient visits. Although an intervention may require a threshold level of treatment for clinical effectiveness, it is still important to measure the cost of partial treatment. Partial treatment occurs both in clinical studies and in general practice, and there is no justification for ignoring the resources expended simply because the patient dropped out before the threshold of clinical effect.

4.2.2 The Comparator

Whenever possible, the cost of an intervention should be measured against a comparator, whether placebo, "usual care," or another new treatment. The choice of comparator will guide how costs should be measured. A finer level of detail may be needed when alternative treatments are close substitutes than when they are quite different. For example, a comparison of two surgical techniques for coronary bypass would require time in the surgical suite to be recorded in minutes, in order to accurately capture important differences in the costs of the two procedures. If the comparison were between surgery and pharmacotherapy, however, capturing fine distinctions in surgery time may be unnecessary and a less precise method would probably suffice.

Researchers must scrutinize data collection methods to avoid bias that might favor one treatment arm. For instance, suppose that a new drug treatment program aims to reduce VA hospitalizations. If it simultaneously leads to greater use of non-VA services, the cost estimation method should be able to account for both VA and non-VA services with similar levels of accuracy. If the control arm uses more VA care than the experimental arm, then bias could be introduced by relying on more accurate methods for VA services but less accurate methods for non-VA services that tended to underestimate their cost.

4.2.3 Joint Production[4]

In some instances a single product is produced simultaneously with other products. Consider the time of a nurse involved in a clinical research trial. Suppose that patient care activities unrelated to a research protocol take up 25% of the nurse's time; activities which benefit both research and patient care take 50% time; and activities only needed for the research protocol take the remaining 25%. An analyst could justifiably assign as little as 25% or as much as 75% of the costs of this time to research. Which figure is appropriate depends on the question being asked. For example, the percentage of time that would be released if research activities ceased is only 25%.

Incremental cost is often a more useful concept for making decisions about the impact of changes in activities. Incremental cost is the additional cost that results from the production of a good or service, holding the production of all other products constant. The incremental cost of an intervention is the additional cost incurred by conducting the intervention, given that other clinical activities already exist. In the preceding scenario, the incremental cost of research is 25% of the nurse's time. Incremental costs must be stated in terms of a given level of production of other products. The extra cost from an intervention adds to total healthcare costs given current levels of patient care.

4.2.4 Hawthorne Effects

In a famous study of General Electric's Hawthorne plant, researchers determined that employees were becoming more productive not from repeated changes in the work environment but from the knowledge that they were being carefully watched (Franke and Kaul, 1978). The same issue can arise in clinical studies. Patients under study may be more likely to take medications; clinicians may work more slowly in order to avoid accidents, or conversely they may work more quickly in order to appear more efficient. Regardless of the direction of effect, Hawthorne effects will bias study results because they will not appear under normal circumstances if the intervention is adopted widely. Researchers collecting data by direct observation can reduce the probability of Hawthorne effects by making the observation process as unobtrusive as possible. For example, recording an intervention on film and later assessing the time spent would be less intrusive than standing at bedside with a stopwatch and a clipboard.

The process of studying an intervention may itself change the cost. Patients may need to travel farther to a study site than to their usual healthcare facilities, for instance. Likewise, time spent by clinicians or managers filling out data collection forms should not be counted as an intervention cost. When an activity involves both delivery of the intervention and research on its effect, the cost of that activity should be included if the activity was needed to deliver the intervention.

Survey Design and Fielding Methods

Surveys are administered by many means, such as paper-and-pencil, personal interview, computer-assisted interview, telephone, email, and the worldwide web. The choice of format

[4] This section is drawn from Barnett and Garber (1996).

can affect the overall response rate, the response rate for individual questions, and the distribution of responses to potentially embarrassing or stigmatizing questions. The reference book by Dillman (2000) offers a wealth of research and suggestions on survey design and methods for increasing response rates. The ever-expanding literature on comparative survey methods (e.g., Kiernan et al. 2005 and the references therein) is too broad to summarize here. As a rule, however, pilot testing with representative individuals will greatly assist you in developing reliable instruments.

4.3 Calculating Costs

4.3.1 VA Costs for Medical Care

Medical care includes supplies, medicines and compensation for providers and other staff members. There is also the cost of overhead expenses such as building maintenance and utilities.

4.3.2 Cost of Training Staff to Use the Intervention

The cost of an intervention includes the cost of training staff to implement it. This cost needs to be estimated with caution. The cost of training might fall if the intervention were implemented on a large scale. If that seems likely, researchers should make a note of it and prepare an additional set of results with the lower training costs to represent the longer-term cost of the intervention. If the intervention became common, the true training cost would likely be small when averaged across many patients. If so then the cost of training may be disregarded from society's viewpoint, although short-term training costs may be of interest to management decision-makers.

4.3.3 Administrative Cost

Every intervention will have some administrative costs as well, particularly those requiring many separate items or people, or which extend over a long period. Administrative costs should be included if they are not trivial and if they would apply in a typical clinical setting. Time spent on administration can be collected through manager surveys.

Average annual or hourly personnel costs (including both wages and benefits) are available through the VA Financial Management System (FMS) and the DSS National Data Extracts, both of which feature total payments and total hours per fiscal year for about 80 classes of employees (e.g., MD, RN, clinical psychologist, lab technician). See Smith and Velez (2004) for details on how to estimate the employment cost of VA personnel.

4.3.4 Medication Costs

Drug prices vary considerably by buyer, and so interventions that primarily consist of prescription drugs may be cost-effective for some buyers but not for others. The current prices for pharmaceuticals paid by each federal agency are stored in electronic format by the VA's

Pharmacy Benefits Management (PBM) Strategic Healthcare Group (www.vapbm.org).[5] Patients, providers and managers are unlikely to know drug prices, and so collecting them through surveys is not advisable.

Drug prices for private buyers are harder to estimate. Many studies use the average wholesale price (AWP), available in trade publications. This approach is flawed: wholesale prices do not reflect actual prices paid by providers or patients. Specialized sources of data on VA pharmacy costs include the DSS Pharmacy Extract and the Pharmacy Benefit Management V3.0 database. These and other sources are described in Smith and Joseph (2003), available on the HERC web site.

4.3.5 Supply, Equipment and Capital Costs

The costs of supplies and equipment may be gathered through manager surveys or by contacting manufacturers. In the context of direct measurement, manager surveys can be used to collect data on typical wages for each type of employee and for the cost of supplies and equipment. Data collected in this way naturally relies on the knowledge of the managers completing the surveys.

Two caveats are in order. First, supply and equipment costs may fall if a new intervention is widely adopted. Both competition and economies of scale in production can lead the price of goods to fall as the number of items produced rises. Second, large providers like VA can often negotiate substantial discounts. Using the list price of a good may greatly overstate the cost of supplies and equipment.

See Chapter 9 of this handbook for a detailed discussion of methods for estimating VA capital costs.

4.3.6 Other Costs

Other types of costs that need to be measured include the cost of care provided in other healthcare systems, out-of-pocket costs incurred by patients, including the travel cost and non-prescription medications, and the value of patients and informal caregivers' time. This section describes methods for estimating each of these.

Travel Costs

Analyses from a societal viewpoint include travel costs. Patients may be surveyed about the specific mode of conveyance and the number of miles traveled. This adds considerable complexity and may not be worthwhile if patient-incurred travel costs are a small fraction of total costs. An alternative approach is to calculate the straight-line distance from the patient's residence to the healthcare provider and then apply a standard mileage rate, such as the amount

[5] The PBM drug price data are updated daily. PBM staff have created an historical price file that has a single entry for each NDC each time the price for that NDC changes. HERC has also saved a copy of the price file once per quarter since September, 2001. Contact HERC staff for more information.

allowed by the U.S. Internal Revenue Service for business expenses. Without much loss of accuracy, this may be further simplified by estimating travel cost using the distance between the geographic center of the postal zip code of the patient's residence and that of the provider's location. Once a typical mileage has been determined, a reasonable cost estimate may be found by multiplying the miles traveled by the standard IRS mileage reimbursement rate. Rates for recent years are available on an IRS web page: look under "mileage rate" in the agency's FAQ site, www.irs.gov/faqs.

Patients may use public transportation to reach the site of an intervention. In some instances this cost is reimbursable by the VA. From the VA's perspective, transportation and other nonmedical services represent costs of an intervention to the extent that the agency reimburses patients for them. Details of VA benefits are available at the agency web site (www.va.gov). From the perspective of society the total payments for these services must be counted.

Beyond the direct cost of travel is the implicit value of time spent traveling. Patients also spend time in obtaining care. For employed persons the hourly wage is a reasonable measure of time cost. Many veterans and their caregivers are retired, however, and so a wage is often unavailable. To our knowledge, no studies have estimated the time-value of veterans and their caregivers. Analysts will need to make assumptions as a result, and sensitivity analyses are indicated.

Non-VA Care Costs

Patients may obtain healthcare beyond the institution where an intervention occurs. In theory, it could account for a substantial proportion of healthcare spending. As noted earlier, inpatient cost and utilization is best captured by asking patients to submit logs of outside care and then writing to providers for details. An alternative is to conduct periodic surveys that ask the patient to report on healthcare used. If neither patient log nor survey is feasible, administrative sources may be consulted. These include the VA Fee Basis files, and Medicare or Medicaid files.

The VA Fee Basis files contain the cost of inpatient and outpatient services provided to VA patients by contract providers, and by non-contract providers who gave care on an emergent basis. Two types of data – completed inpatient stays and community nursing home stays – also appear in other VA databases. Completed inpatient stays paid under the Fee Basis program are added to the "Non-VA Hospitalization" or "Non-VA PTF" file. The PTF reports discharge date, length of stay, and Diagnosis Related Group, but not the cost of these stays. Community nursing home stays appear in the DSS National Data Extracts for outpatient (not inpatient) care. Further information on Fee Basis data appear in a HERC guidebook (Smith and Chow 2010), available on the HERC web site.

VIReC maintains a database of Medicare utilization and cost data for all VA patients. There is roughly a two-year lag in obtaining data; as of late 2005, the most recent data available are from 2003. Details of file contents and the procedure for obtaining access to these data appear on the VIReC web site at http://www.VIReC.research.va.gov/DataSourcesName/VA-MedicareData/VA-Medicare.htm.

Patient logs and surveys provide information on health services utilization, but not their cost. Cost may be estimated from national surveys such as the Medical Expenditure Panel Survey (MEPS), the Healthcare Cost and Utilization Project (HCUP), and the Medicare Provider Analysis Review (MEDPAR), from surveys carried out by professional societies, and from private firms that manage healthcare claims. Combining utilization and cost data from separate sources requires particular care. Costs in one source may refer to utilization categories that do not match those in other sources. Arbitrary simplifications are often necessary.

Time Costs

Interventions have an economic time cost even when services are provided for free. Patients must spend time to receive an intervention and for transportation to and from the place where it is received. Informal caregivers may also spend time transporting patients and providing unmarketed (unpaid) healthcare. The time spent by patients and informal caregivers carries an "opportunity cost" based on the notion that time is limited, and that absent the intervention, patients and others would use their time for other purposes. If volunteers contribute valuable amounts of time to an intervention (as they might at a hospital), then his or her time should be valued as well.

Time costs of patients and unpaid caregivers are not counted in cost-effectiveness analyses from the perspective of the VA. Russell et al. (1996) recommend a societal perspective for cost-effectiveness analyses, however, and society does value patients' and informal caregivers' time. For employed persons and their caregivers, the hourly wage is a reasonable measure of time cost, but because many veterans are retired a wage may not be available for patients in many VA studies. There are a number of issues to consider in determining a fair time value for persons who are not currently employed; Garber et al. (1996) provide an overview and recommendations. Tranmer et al. (2005) surveys the literature on costs incurred by patients and informal caregivers.

4.4 Characteristics of Survey Instruments

Survey design is an important topic often neglected by health services researchers. Readers should familiarize themselves with the major ideas in order to have a basic understanding of the psychometric properties of survey instruments. References are provided for those who would like to investigate the topics more fully.

4.4.1 Validity

In cost-effectiveness research, surveys are used to measure quality of life, clinical outcomes, and cost components. We refer to the object of measurement as the *construct*, a term from psychology that reflects the intangible nature of concepts like pain, health, and utility (or happiness, or well-being).

A key attribute of a survey instrument is validity. Validity refers to the survey's ability to measure the construct successfully. Aspects of validity include *face validity* (does the survey appear on the surface to measure the construct?), *content validity* (do the survey questions pertain to the construct?), and *construct validity* (does the survey measure the construct well?). Related to construct validity is *discriminant validity*, the ability of the survey questions to

distinguish between different constructs. When a new survey yields results similar to a previously validated survey, the new instrument is said to have high *criterion validity*. Sometimes criterion validity is used as a synonym for *predictive validity*, the ability of a test (or question) to predict results of another test or outcome. For example, the SAT exam would have good predictive validity if it were able to predict college achievement, its stated aim.

For an examination of constructs and validity see Sechrest (2005), part of a supplemental issue of *Health Services Research* devoted to psychometrics.

4.4.2 Reliability

A second important property of surveys is reliability. Reliability refers to the consistency of survey results across time, raters, and questions. For instance, *inter-rater reliability* measures the extent to which different raters observing the same situation will complete a survey the same way. *Test-retest reliability* shows whether a patient completing a survey twice in a short period will give the same answers both times. *Internal reliability* refers to whether questions measuring the same construct receive similar answers.

When data are collected through direct observation, the accuracy of the data will rely on the people collecting it. There are several steps that can be taken to increase reliability. Data collectors must be trained to ensure that they understand the collection forms. Retraining is advisable during lengthy collection periods. The degree of consistency between collectors—known as inter-rater reliability—is an important measure (Dunn 1992; Kelsey et al. 1996). It can be assessed by comparing the results of two or more people collecting data from the same source.

4.4.3 Accuracy

Even small errors in reporting can accumulate if many separate people take part in the intervention. If an activity log requests staff members to list tasks in 15-minute intervals, how will they record interventions that take 5, 10 or 20 minutes? Total intervention time will be underestimated if they round down to the nearest 15-minute interval or overestimated if they round up. Small individual errors can become large if the same upward or downward bias is repeated many times. Solutions include using a more precise measurement system that collects data in 5-minute intervals, using direct observation by a third party who can note the exact time spent, and asking staff members to tally which actions occurred and then assigning each action an average time based on a few direct observations.

Patient surveys rely on the accuracy of individuals' memories. Health care studies may face obstacles beyond the inevitable problem of memory decay. If patients are cognitively impaired or deceased, it may be necessary to locate a proxy who can accurately report the data. And the direction of bias is not consistent: a recent study of mentally ill individuals found that those considered high utilizers tended to understate their service use when surveyed, whereas low utilizers tended to overstate their use (Kashner et al., 1999; but see Goldberg et al. (2002) for a different view). Cognitive impairment and inaccuracy of proxies will affect quality-of-life surveys as well (Atkinson et al. 1997).

Even relatively healthy patients may have inaccurate recall, and the quality of recall will vary across people. Factors found to affect recall in social science surveys include the length of the recall period, the complexity of the respondent's experiences, the quantity of information requested, the number of topics, and whether the events being recalled stand out from other events in the person's mind (Pierret 2001; Sudman et al. 1996; Dugoni et al. 1997; Grootendorst et al. 1997; Mathiowetz 1998; Simmons and Schnelle 2001; Clegg et al. 2001; Nicholson et al. 2000). Studies generally find that more accurate recall is associated with a shorter recall period, fewer questions, focus on a single topic, and fewer events that are confusingly similar to those being queried. Evans and Crawford (1999) reviews validity studies from several countries. A survey with recommendations appears in Bhandari and Wagner (2006).

In an event-history analysis, both the presence of an event and its date are collected. These may be used in health services research to date utilization before or after an intervention. Event-history analyses face the special problem of *telescoping*, in which patients recall an event but assign the wrong date to it. One study reported that accuracy of event dates fell below 20 percent when the recall period was about 12 months (Thompson et al. 1996; Wu et al. 2001). A natural approach is to shorten the recall period. In longitudinal (repeated cross-section) surveys, another tactic is to remind the patient of answers from the previous survey and then to ask whether any changes have occurred since then (Sudman et al. 1996).

In sum, there are a number of strategies to increase the accuracy of survey data. Rather than relying on personal memory, consider having patients and providers keep logs of study-related events. Ask patients to grant permission for you to obtain bills from non-VA hospitals. For questions that rely on memory, minimize the recall period. Ask as few questions as are necessary and limit the focus to a small number of areas.

4.4.4 Testing survey characteristics

A variety of methods are used to judge validity and reliability. A few rely on interviews with potential subjects (face validity) or content experts (content validity). Most are judged by a statistical test of similarity between two sets of results. For inter-rater reliability, for example, the test is of similarity between observations made by two different raters. The particular test chosen will depend on whether the variable being compared is binary and on whether two distributions are being compared versus three or more at once. A wide range of tests may be implemented using standard statistical software packages. For example, Cronbach's alpha, a commonly reported measure of internal reliability, can be estimated through the SAS procedure PROC CORR (SAS Institute 1999). A good resource for definitions and standards is AERA et al. (1985), a document produced by three professional organizations in education and psychology. For an interpretation of reliability and validity as consistency and bias of a distribution, see Salvucci et al. (1997).

When measuring the results, how good is good enough? Over time, standards have arisen for certain tests. For example, a Cronbach's alpha score of 0.80 or higher is considered evidence of strong internal reliability. There is no widely accepted standard for data accuracy. The accuracy of one source must be judged against a standard, and in some cases no independent, highly reliable standard will exist. When it does, as with chart reviews for judging patient or physician reports, collecting the data may be prohibitively expensive.

4.5 Summary

This chapter has presented guidelines for directly measuring costs of VA and non-VA healthcare. Direct measurement is recommended when existing data sources cannot provide enough detail on the effort or cost of an intervention. Data may be collected through direct observation or through surveys of managers, providers, and patients or their proxies. In many cases, a single study will combine direct measurement with data collection from administrative sources and published studies.

There are a number of elements to consider when developing a plan for direct measurement:

- **Perspective**: a perspective for the cost-effectiveness analysis must be chosen; options include societal, VA, and patient/family viewpoints; some studies include two cost-effectiveness analyses from different perspectives (e.g., VA and societal)
- **Cost Elements**: a plan for collecting data on each cost element should be determined during the planning phase of a study
- **Healthcare Process**: the process of care must be understood in order to distinguish actions need to carry out the intervention from actions taken only to study it
- **Method**: the use of direct observation, activity logs, manager surveys and patient/proxy surveys must be tailored to meet the data needs and financial limits of the study; avoid methods that may bias the outcome due to data collection difficulties
- **Feasibility**: the method must be affordable and must yield results that are sufficiently accurate and precise

Researchers considering whether to use direct measurement methods may contact HERC for guidance. This should be done during the planning phase of the study in order to ensure that feasible methods are chosen.

4.6 Labor-Management Notification

VA has contracts with labor unions representing many employees, including some physicians and many nurses. Before fielding a survey to VA employees, contact your local VA human resources office to determine whether the respondents include any bargaining unit members. If the survey will go to employees at multiple sites, ask the local office how to learn about bargaining units at other sites.

If bargaining unit members will be surveyed, most likely you must provide the union(s) with an advance copy of the survey. The copy is for notification purposes only. It may be possible to provide a single copy of the survey for the sake of covered employees at multiple sites.

5. Inpatient Medicare Pseudo-bill Estimation

Chapter 4 illustrated one microcost method, direct measurement. This chapter introduces a second microcost method, the *pseudo-bill*. The pseudo-bill method can be used to estimate the cost of inpatient care; it can also be used to estimate outpatient costs, as described in Chapter 7. Like all microcost methods, creating pseudo-bills consists of assigning costs to each part of an encounter, and then summing to find a single cost for the entire encounter.

The pseudo-bill method for inpatient VA care relies on Medicare payment methods. VA cannot bill Medicare for care that it provides to veterans, but calculation of a hypothetical Medicare reimbursement may still be useful to cost analysts who wish to estimate the resources used to provide VA inpatient care. Medicare reimburses both hospitals and providers for the cost of an inpatient stay. These two components are considered in turn.

5.1 Facility Payment

Medicare reimburses hospitals based on the Diagnosis Related Group (DRG) assigned to the inpatient stay. Medicare determines the national average charge for each DRG and expresses them as relative values; these are known as DRG weights. A schedule of DRG weights is published annually by Center for Medicare and Medicaid Services (formerly the Healthcare Financing Agency) on its web site (www.cms.hhs.gov). The weights are also available at the VA Austin Information Technology Center in a SAS file and are printed as a Final Rule in each September issue of the *Federal Register*.

Medicare pays a standard amount for each unit of DRG weight. The program makes additional payments to hospitals for capital, to compensate them for outlier cases, for the indirect and direct costs of medical education, and to assist hospitals that have a disproportionate share of indigent and Medicaid patients. Over time, capital payments are being phased into the DRG payments.

The CMS web site features downloadable applications – known as *pricers* – that enable researchers to estimate the Medicare facility reimbursement for a particular facility, DRG, and length of stay (LOS). A separate pricer is provided for each fiscal year. Pricers are currently available for the following facility types: inpatient acute, skilled nursing (SNF), home health, inpatient rehabilitation, and long-term care. The URL is http://www.cms.hhs.gov/PCPricer.

The Medicare pricers provide a high level of detail on facility reimbursements. Several dozen cost-related fields are displayed for each worked example, among them the total Medicare payment, disproportionate share (DSH) payments, and pass-throughs for direct medical education. Because pricer calculations are specific to particular combinations of facility, DRG (MS-DRG since FY2008), and LOS, they are not feasible for use in estimating national or regional average payments. The data must also be entered separately for each stay; there is no facility for batch processing.

HERC has prepared a spreadsheet that shows how to construct an average Medicare payment for an inpatient stay. It uses the same types of data that underlie the pricers and provides similar

outputs, all in an easily comprehensible format. A worked example illustrates the breakdown of the payment into factors such as the "labor-related standardized amount," the "non-labor-related amount," and adjustment factors specific to the hospital and the locality. The spreadsheet appears as a download from this HERC web page: http://www.herc.research.va.gov/resources/faq_i12.asp.

Appendix 1, at the end of this guidebook, presents an alternative method for estimating Medicare reimbursements. Although not as detailed nor as accurate as the pricer for individual stays, it is accurate on average and allows for faster calculation of reimbursements for multiple stays.

5.2 Payments to Physicians for Inpatient Care

Physicians prepare bills to Medicare using Current Procedural Terminology (CPT) codes to characterize the services that they provide. The Medicare fiscal intermediary confirms that each bill is appropriate and calculates a payment based on a system of relative values assigned to each code. The Medicare conversion factor was $37.90 per billed relative value unit in FY2005.

VA physicians do not use CPT codes to characterize services provided to inpatients, and so analysts must calculate the average payment for each DRG by other means. Two studies that have determined the mean Medicare payment to physicians for services provided to hospitalized patients in each DRG are Miller and Welch (1993) and Mitchell, et al. (1993). Their estimated payment rates may be used for VA research, but doing so implies that every patient assigned to a given DRG received exactly the same physician services. This assumption is not far-fetched, however, as additional physician services often result in a stay being assigned to another, more expensive DRG.

In some cases it will be advisable to adjust the physician payment. For example, a patient with an unusually long length of stay (LOS) most likely has more physician visits than the average. In this situation, one might increase the physician payment to account for the longer stay, or reduce the payment to account for shorter stays. For example, the typical Medicare payment for a physician visit (CPT 99232) was $56.01 in FY2000; one method would be to add $56.01 for each day that an inpatient stay extends beyond the national mean LOS. Other adjustments to physician payments are possible as well.

5.3 Medical Care Cost Recovery Program

Some VA patients are covered by private insurance policies. By law, VA has the right to bill the private insurers for treatment of non-service-connected conditions. Some copayments are recoverable as well. These efforts fall under the Medical Care Cost Recovery (MCCR) Program. The program is implemented at each VA medical center. Summary data are stored in the MCCR National Database in VA FileMan format. We have chosen not to use MCCR data in the estimation of inpatient pseudo-bills from a belief that they are incomplete and would not substantially improve to the Medicare-based method described earlier.

6. Outpatient Pseudo-Bill Estimation

A pseudo-bill can be created for outpatient payments in a way similar to that outlined in Chapter 5 for inpatient treatment. This chapter describes methods and data sources for doing so. It outlines the methods used to create the HERC Outpatient Average Cost Datasets. A HERC guidebook (Phibbs et al. 2009) provides additional details on the creation of the HERC Average Cost Datasets. This chapter is a condensed version of that report.

Researchers who need to estimate the cost of VA care may choose a microcost approach such as pseudo-bills, or may choose an average-cost approach using the HERC Average Cost Datasets. The HERC average-cost method made a number of simplifying assumptions that understates the true variation in costs. This chapter is offered to assist the analyst who wishes to prepare a pseudo bill with her own assumptions.

6.1 Overview: Estimating Payments and Costs

VA characterizes the services it provides to outpatients using the Current Procedure Terminology (CPT) coding system.[6] In a typical year, VA provides some 60 million outpatient encounters in hundreds of VA clinics. The VA characterizes these services with more than 10,000 different CPT codes.

The Medicare reimbursement method is a good source of payment rates because Medicare is a national program. Its payments are based on the economic cost of providing services, rather than the accounting cost.[7] Medicare is also a major healthcare provider, paying 22% of the cost of physician services provided in the U.S. Finally, its reimbursement rate represents costs from a useful perspective, that of the healthcare payer.

Because VA also provides services not covered by Medicare, one must use other sources as well. Surveys of physicians and health plans are the primary sources of additional information.

6.1.1 Assumptions made to estimate payments and costs

A number of assumptions are needed to create a pseudo-bill based on VA outpatient records. In order to apply Medicare reimbursement methods, HERC made the following assumptions:

1) All ambulatory care is comprehensively characterized by the CPT codes used in national VA databases.
2) All CPT codes used by VA represent valid services that should be assigned a cost.
3) Costs are proportionate to payment rates.
4) Some of Medicare's reimbursement methods are not appropriate for the VA.
5) Non-standard CPT codes represent valid costs.
6) Total payments should include facility payments.

---

[6] In this chapter the phrase "CPT codes" will include HCPCS codes.

[7] Economic costs equal accounting costs plus the opportunity costs of production. In the long run the economic costs represent society's expenses more accurately.

7) VA incurs the cost of ambulatory care reported in the CDR (through FY2004) or DSS (since FY2005).
8) Indirect costs are incurred in proportion to direct costs.
9) The distribution of costs between inpatient and outpatient care in CDR and DSS is accurate at each individual medical center.

A discussion and application of each assumption appears in Phibbs et al. (2009).

6.1.2 Facility Payments Necessary

Most VA care is provided in a setting that meets the Medicare definition of a facility. Medicare defines a facility as a hospital-based clinic, a skilled nursing facility, a free-standing surgery center, a comprehensive outpatient rehabilitation facility, or a community mental health center. The VA has these facilities and others. When care is provided in this type of facility, researchers should include a facility payment in addition to a provider payment when calculating a pseudo-bill. The HERC Average Cost estimates always include a facility payment; the analyst may want to exclude this payment in estimating the cost of care provided in satellite clinics.

6.2. Provider Payments

One method for determining provider payments is to determine charges, costs or payments for similar services outside the VA. A natural choice is Medicare. Medicare payments differ between office-based and facility-based physicians. When care is provided in a "facility" (as defined by Medicare), then Medicare payment rate for facility-based physicians may be used. When care is provided outside of facility, as in a office-based physician's practice, the non-facility payment should be used.

Medicare provider payments cover physician services, laboratory tests, diagnostic imaging, and medical supplies. Medicare uses the Resource-Based Relative Value Scale (RBRVS) to calculate provider payments. It produces *RBRVS values*, weights based on the time needed to provide a service or perform a procedure. The values also reflect the minimum training required to provide a given service and the stress level of the task. The RBRVS system replaced reimbursement based on historic payment rates.

6.2.1 Application of Medicare Reimbursement Methods

The Medicare reimbursement algorithm is complex. HERC adapted and simplified it when creating its Average Cost estimates. These adaptations are briefly discussed below.

- **Geographic Adjustment** HERC used the national average RBRVS payments rather than the payments adjusted for geographic differences. Researchers interested in creating pseudo-bills applicable only to local areas may wish to use the geographic adjustments.

- **Procedures Subject to Global Reimbursement Rates** Medicare reimburses providers with a global payment for most procedures. The global payment is for pre-operative visits, the procedure, and post-operative care, regardless of the number of visits requited. HERC did not use the global rate; instead, it estimated the reimbursement for each visit

and the procedure. Because post-operative visits are reimbursed via global payments, Medicare does not reimburse for post-operative visit (CPT code 99024). HERC used the reimbursement rate for an Evaluation and Management visit with an established patient (CPT code 99211).

- **Bundling of Professional and Technical Components** Medicare allows payment for certain services to be divided into a professional and technical component. For example, an x-ray consists of the technical component, taking the x-ray, and a professional component, the physician's interpretation of the x-ray. These services are distinguished by a two digit code, in addition to the 5-digit CPT code; the technical code is identified as "TC" and the professional component as "26". At this writing, these supplemental codes are not used by VA. HERC used the bundled reimbursement rate. Pseudo-bills for VA utilization should include both the professional and technical components.

- **Discounting for Multiple Procedures** Medicare provides indicators to identify procedures subject to discounting rules when other procedures are performed on the same day. Standard payment adjustment rules are applied to multiple procedures in that instance. This entails ranking the procedures by fee schedule amount and applying the appropriate reduction to each procedure. HERC applied this method with some simplifications, as noted in Chapter 3 of Phibbs et al. (2009). In fiscal year 2007 approximately 2% of VA outpatient procedures were eligible for discounting.

6.2.2 Relative Value Units and Fee Rate Conversation Factors

The RBRVS is expressed in terms of relative value units (RVUs). Medicare issues two conversion factors for converting RVUs to dollars: one for anesthesiologists and one for all other providers. The conversion factors for anesthesiology and for other providers used to create the HERC values are listed in Table 4, rounded to two digits after the decimal place.

Table 4: Medicare Conversion Factors, RVUs to Dollars, 2003-2008

	FY2003	FY2004	FY2005	FY2006	FY2007	FY2008
Anesthesiologists	$17.05	$17.50	$17.76	$16.96	$16.19	$17.82
All Other Providers	$36.79	$37.34	$37.90	$36.18	$37.90	$38.09

6.2.3 Sources of Provider Payment Data

This section describes assumptions that HERC used to estimate payments for VA services characterized by non-standard use of CPT codes. While we believe these methods and sources are generally applicable, there may be others that are equally appropriate for a particular study.

Medicare Reimbursement Schedule

The primary source for payment estimates is a schedule that lists the RVU for each CPT reimbursed by Medicare. We used the 2000 payment schedule (St. Anthony's RBRVS) for

FY1998 - FY2000 and the concurrent year's schedule for every year since. We derived the estimated payment for each CPT by multiplying the relative value (RVU) by the conversion factor for that year.

For a small number of procedures it was necessary to use Medicare RVUs from other years. Some CPT codes were dropped and others added between 1998 and 2001, for example, and so we consulted the Medicare RBRVS schedules from 1997 through 2002 to find RVUs for the codes that were added or deleted in the intervening years.

Gap Codes - RBRVS Methods for Services not Covered by Medicare

Many outpatient professional services provided by VA are not covered by Medicare, such as telephone contacts and some preventive care activities. One may nevertheless wish to assign comparable reimbursements and to estimate their costs.

The RBRVS method is used to estimate RVUs for the provider payment for most services not covered by Medicare. A table of these listings appears in Ingenix (2009) and earlier editions. As these professional services represent gaps in Medicare coverage, codes for these services are often referred to as *gap codes*.

Cost Pass-Through Payments

A few CPT codes represent supplies, devices, or pharmaceuticals that Medicare historically paid on a "cost pass-through" basis. We assigned these a HERC provider payment of zero dollars.

Dental Fee Surveys

We estimated HERC values for dental services using the median charge reported in two national surveys. We adjusted charges from the survey year to the utilization year using the average ratio of Medicare conversion factors for the same years. Starting with FY2001 data the HERC values for nearly all dental services are based on gap code RVUs rather than dental charges.

VA Contract Rates

For VA compensation and pension (C&P) exams we used a 1998 national average contract cost of $437. This rate is adjusted annually for inflation.

California Workers Compensation Charges

Payments allowed by the California Workmen's Compensation System were used to calculate HERC values for a small number of rehabilitation services not covered by Medicare (State of California 1999). The RVUs were rescaled to be comparable with the Medicare conversion factor.

Physician Charge Surveys

For the remaining physician services that had no payment amount, we used the median charge reported in a survey of U.S. physicians (PFR, 2000). We adjusted the charges to make them

consistent with Medicare reimbursement rates. For services covered by Medicare that had a charge reported in the survey, we calculated the ratio of FY2000 Medicare reimbursement rates to this survey's median charge. We multiplied the charges in the survey by this value to find the HERC value for FY2000 and then adjusted appropriately for earlier and later years.

Private-Sector Claims Data

Since FY2002 we have used private-sector claims data from William Mercer Company to find payments for CPT codes for which HERC lacked Medicare and Ingenix data. To reduce variance we classified the resulting charges into nine groups and calculated the ratio of each group's average charge to the Medicare payment. We then used the ratios to scale the Mercer data so that they were comparable to Medicare data.

Pharmacy Data

In some cases a medication is administered by a provider during an outpatient visit. These are assigned HCPCS codes beginning with 'J' or 'S.' To assign these a cost in FY1998-FY2000 we used wholesale drug prices printed in the 2000 Drug Topics Red Book. Since FY2001 we have relied primarily on cost data from the Pharmacy Benefits Management (PBM) V3.0 database, a record of outpatient VA prescriptions. The Red Book continues to be used for roughly a dozen CPT codes each year.

Prosthetics Data

The National Prosthetics Patient Database (NPPD) is a registry of prescribed prosthetic and orthotic items such as hearing aids, eye glasses, and some surgical items (e.g., stents, drainage tubes). We scaled the VA payments up to match the typical Medicare payment and then used the rescaled VA payments for prosthetics-related CPT codes.

6.2.4 Payments for Non-Standard Codes

Some CPT codes used by VA are not normally used to bill for ambulatory care. HERC made assumptions to estimate a hypothetical payment associated with each of these codes. The examples below are the coding problems encountered by HERC in creating the Outpatient Average Cost Datasets and the assumptions made in order to assign payments.

Codes for Unlisted Services and Procedures

Each group of CPT codes includes a code for "unlisted service or procedure," designed to allow coders to represent services that are not otherwise represented with a CPT code. These codes are commonly used in VA. Neither Medicare nor any other provider assigns an RVU or payment to codes for unlisted procedures. These codes may in fact represent services for which there is a more specific CPT code and an associated RVU. In the absence of more precise information about the services represented by the unlisted codes, our strategy was to apply the weighted average payment for similar procedures. For example, HERC staff calculated a payment for "unlisted hematology and coagulation procedures" as the weighted mean payment of hematology and coagulation procedures actually performed by VA, weighted by their frequency.

Obsolete Codes

VA uses CPT codes that have become obsolete and therefore did not have a payment associated with them in RBRVS schedules (e.g., Ingenix 2004). We used the following rules to assign values to obsolete codes:

- When an old code was replaced by a single new code, we used the RVU of the new code.
- When an old code was split into two or more codes with identical RVUs, we used this RVU. If the old code was split into two or more new codes with different RVUs but only one appears to apply to VA patients, we used that RVU.
- When an old code was replaced by more than one new code with different RVUs, we estimated the payment for the old code as the average payment for the new codes weighted by their frequency in VA data.

6.2.5 Inpatient Procedures

Medicare has identified CPT codes for services that may only be performed on an inpatient basis. Medicare does not reimburse providers for these services when they are provided in the ambulatory setting.

VA used 1,031 different CPT inpatient codes to characterize ambulatory care in FY1998. Most of these codes were used infrequently, with the exception of 32 CPT inpatient "evaluation and management" (E&M) codes. These 32 codes were used to characterize more than 250,000 ambulatory encounters in FY1998. By FY2008 the number had fallen to 17 inpatient E&M codes representing over 36,000 procedures. In the absence of more precise information about the services provided, we assumed that they were actually ambulatory care evaluation and management visits and assigned them payments based on the RVUs associated with the corresponding outpatient E&M codes. Uncommon inpatient codes may be assumed to reflect coding errors. Without further information, we assigned the service average VA payment per CPT code for that category of care.

6.2.6 Pediatric and Obstetric Services

For pediatric codes having a direct adult equivalent, we assumed that there was a coding error and used the payment for the corresponding adult procedure. If there was no adult equivalent then we assigned the average VA payment per CPT code for that HERC category of care. Obstetric codes were examined for content and frequency of use. Those used over 100 times in a year were assumed to be coded correctly and were assigned a cost according to standard methods. Those used 100 times or fewer were assumed to be coding errors and were assigned the average VA payment for that category of care.

6.2.7 Similar Modes of Care

In some cases VA uses codes that are similar but not exactly the same as CPT codes currently in use. We assigned them the RVUs basis of similar CPT codes. Guidance from a knowledgeable clinician should be obtained before making this type of assumption. If there are no similar codes, one solution is to assign an average payment based on all similar CPT codes. In the

HERC Outpatient Average Cost Datasets, for example, we calculated a national average payment per CPT for each category of care, identified by clinic stop:

$$\text{national average payment per category} = \frac{\text{total payments in the category}}{\text{no. of procedures/services represented by CPT codes in the category}}$$

6.2.8 Remaining Codes

Once all methods described above were applied there were a small number of CPT codes remaining for which no cost was available. We assigned these the national average HERC value. This method was employed for 55,611 encounters in FY1998 represented by 122 unique CPT codes. The frequency of these remainder codes has been rising over time. By FY2008 it reached 248 CPT codes and 134,527 encounters.

6.2.9 Discounting

Starting in FY2007, we applied Medicare discounting rules to procedures reported on the same day as other procedures. The rules varied by the procedure type and whether more than one type was reported on a single day. In FY2007 there were 4,103 CPT codes eligible for discounting, approximately 2% of the total count of procedures that year. The difference in estimated payments due to discounting was calculated at less than 1%. We therefore conclude that any bias in previous years' data was minor.

6.3 Facility Payments

In addition to a physician payment, Medicare reimburses healthcare facilities for certain types of ambulatory care. The types of facilities eligible for the additional reimbursement include hospital-based clinics, emergency rooms, free-standing ambulatory surgical centers, Federally-qualified health centers, skilled nursing facilities, rural health clinics, comprehensive outpatient rehabilitation facilities, home health agencies, and hospices. Facility reimbursements are a significant expense to Medicare, typically equal to the total payment for physician services at the same facility.

All VA acute care hospitals meet the Medicare definition of a "healthcare facility," but some VA visits occur in satellite outpatient clinics that may not. HERC decided to include the facility payment for all outpatient visits. This was done because of concern that VA databases may not reliably identify the site where care is provided. For example, visits to satellite clinics that involve laboratory tests run at the parent hospital are sometimes assigned the hospital's location code.

6.3.1 Identifying Medicare Facility Reimbursement

In August, 2000, Medicare adopted a new method of paying ambulatory care facilities. This method assigns CPT codes to Ambulatory Payment Categories (APC). A facility reimbursement was assigned to each APC. The same method may be used to estimate the appropriate payment for facilities not covered by Medicare.

Medicare assigned CPT codes representing similar services with similar facility costs to Ambulatory Payment Classification (APC) groups. It determined the average facility reimbursement for each APC from historical payment data. When a visit involves several CPT codes, the facility receives an APC payment for each code. In the case of multiple procedures, the APC payments for many surgical procedures are reduced by 50%. The APC payment for a surgical procedure is not reduced, however, if it is the largest APC payment for the visit.

Under the Medicare rules, the following services and procedures are not eligible for facility payments:

- Procedures for which the facility reimbursement comes from the APC payment for another CPT code (e.g., anesthesia)
- Services in which the facility payment is provided with provider reimbursement (e.g., laboratory tests, dialysis, medical supplies)
- Procedures that can only be provided in an inpatient setting

Two primary sources of payment rates are Medicare rules for year 2000, the first year in which Medicare used the APC to calculate facility payments, and the new APC categories created for 2001. HERC estimated facility payments for earlier years by assuming that facility payments grew at the same rate as physician payments. We found this growth rate by comparing the conversion factor for physician payments in the year of the visit to the conversion factor for the year of the APC payment schedule.

The use of bundled payment rates for CPT codes in some cases led to double-counting of the facility payment portion of the estimated cost. To avoid this, starting in FY2007 HERC extracted the professional component of the provider payment if the facility reimbursement was available based on the APC.

6.3.2 Other Codes without Facility Payments

VA used many codes that are not covered by Medicare and have not been assigned an APC. The analyst must consider if a facility payment is appropriate. The Medicare rules do not allow facility payments for laboratory tests, dialysis, dental services, and medical supplies. Also excluded are services ordinarily provided in the inpatient setting, and payments for procedures like anesthesia; the facility reimbursement comes from the APC payment for another CPT code. For services for which an APC payment seemed appropriate, HERC used the APC payment of similar procedures. We advise checking these substitutions with a clinical researcher.

6.3.3 Gap Codes—Facility Payments for Services not Covered by Medicare

There may be additional CPT codes that should be assigned a facility payment but are not assigned an APC group by Medicare. For services that can be provided in an office-based setting HERC calculated the facility payment based on the RVU for practice expense.

The RVU for practice expense was scaled to the Medicare payment for facilities by comparing Medicare-covered services that have both a facility payment based on APC group and a provider

practice expense for office-based providers. We found the median ratio of APC facility value to provider practice-expense payment was 2.22. We estimate the facility payment by multiplying the gap-code practice-expense RVU by this ratio.

6.3.4 Other Non-standard Codes

Unlisted Services and Procedures

Medicare does not assign an APC payment to codes for unlisted procedures (miscellaneous categories of procedures not otherwise assigned CPT codes). HERC estimate that codes of these procedures as the weighted average facility payment for similar procedures, where the weights are the frequency of VA use of each of the similar procedures.

Obsolete Codes

We followed the same method we used for provider payments to estimate facility payments for services characterized by obsolete codes. If there were only a single replacement APC code that made sense, we used that code. Otherwise, we used a weighted average of replacement APC codes.

Inpatient Codes

VA characterizes some outpatient care with inpatient Evaluation and Management (E&M) CPT codes. HERC estimate the facility payment to be the facility payment for a comparable outpatient E&M codes. For other inpatient CPT codes used by VA to characterize outpatient services, we assigned them a weighted national-average facility payment.

6.3.5 Average HERC Facility Payment per Clinic Type

There were still some CPT codes that were not assigned a facility payment by the methods described above. HERC assigned these the average facility payment for all other codes for that type of outpatient clinic.

6.4 Other Data Sources

Beyond Medicare there are many data sources that are available for use in creating pseudo-bills. Hospital and clinic administrative records capture private-sector healthcare payments. Some published studies have used surveys to collect data from one or more individual providers on the cost of a relatively small number of procedures or events. Large provider organizations such as Kaiser-Permanente have used their own administrative records to produce average prices for outpatient procedures. Data from a range of providers nationwide are available from private firms that have built databases of medical claims (encounters for capitated plans).

There are several sources of data for prescription drugs as well. The VA's Pharmacy Benefits Management (PBM) Group has placed on its web site (www.pbm.va.gov) several text files containing the contracted prices paid by every federal agency for roughly 15,000

pharmaceuticals. PBM also maintains an historical file featuring changes in contract prices over the past several years.

Two DSS National Data Extracts provides direct and indirect costs for pharmacy transactions. One is at the level of individual prescriptions and provides considerable detail about costs and mode of delivery. It contains data on all pharmacy transactions since the start of FY2002. The second file rolls up pharmacy services to the level of a day, so that a single record includes all pharmacy activity for a patient on that day. This file cannot be used to study individual prescriptions because there can be multiple pharmacy transactions for a patient in one day. The file is often sufficient for cost analyses, however, such as determining the total pharmacy spending for a particular individual over a defined period of time. The day-level file extends back to FY1999.

Both files report direct costs. Because these include the cost of staff time, they do not match the drug purchase prices listed in the PBM V3.0 database.

For pharmaceuticals not covered by federal contracts, there are private-sector sources of drug prices. A widely used reference is the Red Book, published by Medical Economics Co. and updated annually (e.g., Drug Topics Red Book 2008). Many researchers use its Average Wholesale Price (AWP) as a measure of typical costs for the drug. Medicaid drug payments tend to follow this formula:

$$\text{Medicaid reimbursement} = (\text{AWP}-n\%) + \text{dispensing fee}$$

where 'n' varies by state and sometimes by generic vs. brand identity. See Drug Topics (2004) for Medicaid pharmacy reimbursement rates by state in 2004. In some states the payment is based on Wholesale Average Cost (WAC) rather than or in addition to AWP. The dispensing fee is relatively small, usually less than $5.00 per prescription. Thus the AWP is reasonably proportional to the Medicaid price.

Federal agencies negotiate discounts with drug manufacturers. As a result, the AWP typically overstates the purchase price paid by federal agencies, including VA. Although the AWP is not useful for estimating VA costs, it can be used in a sensitivity analysis to determine whether varying the cost of prescription drugs affects study outcomes. It can also be used to estimate the Medicaid payment for a similar prescription.

A number of private firms also sell drug price data. These have the advantage of being payments rather than wholesale charges. They will be most accurate for estimating average private-sector drug payments.

7. Estimating Costs with a Statistical Cost Function

A *statistical cost function* represents the third microcost method for estimating the cost of VA hospital stays. It requires a suitable source of non-VA data that includes costs (or cost-adjusted charges) and the factors most influential in explaining the variation in resources, such as the characteristics of the patient, the hospital, and the hospital stay. The cost function is estimated through regression analysis with cost as the dependent variable and the characteristics as independent variables. The resulting coefficients may be used to create fitted values of the dependent variable, representing VA costs given the observed levels of VA utilization and the function's parameters.

Cost functions require less data than a pseudo-bill. Creating pseudo-bills can be difficult because VA doesn't gather the same information that non-VA hospitals and physicians use to bill for their services. An especially important deficiency in the VA data is potentially incomplete recording of non-surgical procedures.

Cost functions were used to estimate the cost acute medical-surgical stays in the HERC Average Cost estimates. The careful analyst may want to improve on the HERC method by estimating a regression that includes additional factors, such as comorbidities and procedures that do not affect DRG assignment; the patient's vital status at discharge, or data not available from administrative datasets.

7.1 Independent Variables

The analyst will certainly wish to include length of stay (LOS) as an independent variable in models of the cost of hospital stays. Avoid the assumption that the costs of acute medical-surgical stays are proportionate to the length of stay, however. The daily cost of care is highest in the early part of the stay, and declines as the stay progresses. Using the square and cube of LOS is advisable, or some other specification that allow the coefficient on LOS to change as the stay progresses.

Hospital stays at VA facilities are longer on average than those at non-VA facilities. It is unlikely that extra days of stay in VA facilities have the same cost as extra days of stay at non-VA facilities. Therefore care must be exercised in simulating VA costs. One approach assumes that the median length of a VA stay has the same cost as the median length of a non-VA stay, holding all other factors constant. An extension of this method would be to replace the LOS with the rank of the patient's LOS among all stays.

The DRG weight is another important explanatory variable. CMS uses this relative weight to reimbursement hospitals; it captures the effect of diagnosis and procedures on hospital costs. The DRG weight explains more of the variance in the cost of acute medical and surgical hospital stays than does length of stay.

7.2 Choosing the Model Specification

Choosing an acceptable model starts with a consideration of bias and precision. Bias, the opposite of accuracy, reflects how well the chosen model estimates the "true" coefficient. Precision relates to statistical significance: the greater the precision of the estimate, the smaller the confidence region around the estimate and the greater the level of statistical significance. If the purpose of the regression analysis is simply to estimate predicted values of the dependent variable, then any unbiased (or *consistent*) model will suffice, including ordinary least squares (OLS) in most (but not all) situations. If the analyst wishes to make statements about the statistical significance of coefficients, however, then precision must also be taken into account, and the choice between models becomes substantially more complex.

Why is OLS not right for every situation? Cost data typically are not normally distributed. Estimating a function with a skewed (non-normal) dependent variable violates the assumptions of OLS and causes inconsistency. This problem can be overcome by assuming a nonlinear relationship between the dependent and independent variables. A common choice is a logarithmic relationship implemented by transforming the dependent variable, substituting the natural log of costs for actual costs. Other nonlinear relationships may be appropriate as well. Two alternative formulations of the logarithmic linkage are given below:

(1.a) $\ln(cost) = \beta_0 + X_1\beta_1 + X_2\beta_2 + \ldots + \varepsilon$

(1.b) $cost = exp(\beta_0 + X_1\beta_1 + X_2\beta_2 + \ldots) + \varepsilon$

Equation 1.a is the standard log-linear model usually estimated by OLS. Equation 1.b is similar but shifts the (anti-)logarithm to the right side of the equal sign. As regression models they produce similar but not identical coefficients and standard errors. Both models can be estimated easily in major statistical packages, model 1.a with ordinary least squares regression (PROC REG in SAS, *reg* in Stata) and model 1.b with iteratively reweighted least squares (PROC NLIN in SAS, *xtgee* or *glm* in Stata).

7.3 Predicting Costs from Regression Results

Regression analysis is often performed in order to predict costs under hypothetical circumstances. This section describes methods for predicting costs, drawing heavily on Manning and Mullahy (2001). Although that paper is statistically sophisticated, we recommend investing time to read it. The payoff will be largest for researchers interested in determining the partial effect of a particular factor on total costs, such as the impact of an intervention.

7.3.1 OLS with Log Transformation: Homoskedastic Case

One cannot predict costs from equation 1.a simply by taking the anti-log (exponential) of the fitted value ($\hat{\beta}_0 + X_1\hat{\beta}_1 + ... + X_k\hat{\beta}_k$). The fitted value is subject to a retransformation bias. There is a simple approach to retransformation, called *smearing*, that will be appropriate under two conditions: the model was estimated with OLS, and the error term does not depend on any function of the X variables (a property known as *homoskedasticity*).

The expected value of cost when $X=X_0$ is

$$(2) \qquad E(cost) = E\left(\exp(X\hat{\beta} + \varepsilon)\right)$$
$$= \frac{1}{n}\sum_{i=1}^{n}\left((\exp(X_i\hat{\beta} + \hat{\varepsilon}_i)\right)$$
$$= \left(\exp(X\hat{\beta})\right)\left[\frac{1}{n}\sum_{i=1}^{n}\exp(\hat{\varepsilon}_i)\right]$$

The smearing estimator is the term in square brackets, the mean of the exponential of the residuals.

To find the smearing estimator, save the regression residuals. Then exponentiate each residual and calculate their mean. Typically this will be a value between 1 and 2. The smearing estimator is then multiplied by the fitted value (exp($X\hat{\beta}$)) to yield the predicted value of the dependent variable.

As emphasized in Mullahy (1998), the smearing method is *only* applicable to log-linear models estimated by OLS that have homoskedastic errors.

7.3.2 OLS with Log Transformation: Simplest Heteroskedastic Case

If the error term from the log-linear regression (equation 1.a) depends on some combination of X variables, then there is *heteroskedasticity*. The smearing method will produce biased results in the presence of heteroskedastic errors, but a heteroskedastic retransformation may be available instead (Mullahy 1998; Manning and Mullahy 2001).

To determine the cause of the heteroskedasticity, regress the square of the log-scale errors (those from equation 1.a) on the independent variables:

$$(3.a) \qquad \hat{\varepsilon}^2 = \gamma_0 + X_1\gamma_1 + X_2\gamma_2 + \ldots + \eta,$$

where η is an error term for the new regression.

The errors are homoskedastic if there are no significant coefficients on the X variables. In that case, the simple log-linear model (equation 1.a) is unbiased and the smearing method would be appropriate. If there are only one or two significant coefficients and they correspond to binary variables, then a correction for heteroskedasticity is needed but will not be taxing. If many variables are significant, however, or if one is continuous, then it may take considerable work to create a retransformation factor.

Consider the simplest case, where one binary variable, X_1, is significant in equation 3.a. Using the estimated coefficients from 3.a, calculate the predicted value of each square-error term:

$$(3.b) \qquad \hat{v} = X_1\hat{\gamma}_1 + X_2\hat{\gamma}_2 + \ldots X_k\hat{\gamma}_k .$$

Note that $\hat{v}$ is the predicted variance of the log-scale errors. The expected value of Y (raw dollars) will then be

(3.c) $E(y|x) = \exp(\hat{\beta}_0 + X_1\hat{\beta}_1 + ... + 0.5\hat{v})$,

if we assume a logarithmic transformation (as in equation 1.a) and a normally distributed error (Duan 1983).

7.3.3 Other Cost Models

A discussion of all models with transformed dependent variables is beyond the scope of this chapter. Interested readers should consult several recent journal articles. Mullahy (1998) lays out the econometric problem in detail and derives the bias of the smearing estimator when heteroscedasticity is present. Manning and Mullahy (2001) and Basu et al. (2004) describe several alternatives: ordinary least squares on the natural log of y; GLM variants (such as gamma regression with log link and Weibull regression with log link); and the Cox proportional hazards model. They conclude that no single model is best under all circumstances.

Although OLS is always consistent (unbiased) when errors are homoskedastic, it still may not be the best model. Another important consideration is precision (or *efficiency*), which reflects the size of the significance interval bracketing each coefficient. Manning and Mullahy (2001) details several models that are superior to OLS under certain conditions, including nonlinear least squares, poisson, and gamma specifications. It also provides diagnostic tests to reveal the optimal choice among those models. The discussion in Mullahy (1998) is also helpful in understanding the distinctions among these models.

A few articles display results of several alternative models rather than choosing one or two among them. Bao (2002), for example, compares results of three models of outpatient care received by persons with mental illness. Typically the purpose of such papers is to provide advice for other researchers about the relative importance of choosing one model over another. The generalizability of such results, however, is uncertain.

7.4 Marginal Effect of an Independent Variable

Often a researcher wants to know the impact of some variable X_j on predicted costs. The general formula is

(3.d) $$\frac{dE(y \mid x)}{\delta x} = \left(\beta_1 + 0.5\frac{\delta\hat{\varepsilon}^2}{\delta x}\right)E(y \mid x),$$

where $\left(\frac{\delta\hat{\varepsilon}^2}{\delta x}\right)$ is the first derivative of the variance with respect to X_i. If we are using a log transformation (as in equation 1.a), then this marginal effect equals the percentage change in Y due to a unit change in X_i. If the variable X_i is binary, equation 3.d reduces to

(3.e) $$\frac{dE(y \mid x)}{\delta x} = (\beta_1 + 0.5\hat{\gamma}_1)E(y \mid x)$$

This value can be determined with a calculator using the results from regressions 1.b, 3.a, and 3.c for heteroskedastic data, or 1.b, 2, and 3.c for homoskedastic.

Thus, the marginal effect is calculated using the result of equation 2 (the smearing estimate) or equation 3.c (the heteroskedastic correction), whichever is most appropriate given the absence or presence of heteroskedasticity. A third method is a nonparametric Monte Carlo-type method, such as bootstrapping. Mullahy (1998) and Manning and Mullahy (2001) provide guidance on how to choose an appropriate method.

7.5 Other Specification Issues

A small library of books covers methods of model specification, and this chapter will not try to summarize them. Many articles using VA data have raised additional pertinent issues and discuss problems specific to VA analyses. Some of the major issues are listed below, with citations to sources that treat the topic.

7.5.1 Case-mix adjustment

The nature and severity of patients' illnesses are strongly linked to total healthcare costs. One method of controlling for these factors is case-mix adjustment. Readers can familiarize themselves with the alphabet soup of adjustment schemes (ACGs, ADGs, HCCs, MDCs, and so on) by reading Anderson et al. (1990), Ellis et al. (1996), or Ettner et al. (2000), among many others. Applications to VA data appear in Phibbs et al. (1997), Rosen et al. (2001), and Sales et al. (2003. A general finding in both private and public health plans is that adding risk-adjustment scores greatly increases the predictive power of healthcare spending models. Few if any risk-adjustment schemes are in the public domain, and so the programs that implement them—known as "groupers"—must be purchased from their manufacturers.

7.5.2 Unobserved patient characteristics

Unobserved patient characteristics such as the propensity to seek care can strongly affect total healthcare spending. Some may be observable in theory, such as health history, while factors like personal motivations and beliefs may be strictly unobservable without interviewing each patient. Fixed effects (FE) and random effects (RE) are two common methods for controlling for unobservable variation, whether at the level of the person, the physician practice, the facility, or some other grouping. Good general discussions of the FE and RE models appear in Greene (2000) and other econometrics textbooks. For applications in standard statistical packages, see the manuals of SAS and Stata (SAS Institute 1997; Stata Corp. 2001). A model of VA costs that includes patient-level random effects appears in Barnett and Swindle (1997).

7.5.3 Robust error specifications

As noted above, heteroskedasticity is common in cost data. Manning and Mullahy (2001) recommends specifying "robust" error structures that allow for heteroskedasticity, and the examples contained therein do so. All standard statistical packages allow the use of robust error terms as part of many regression commands, including SAS (SAS Institute 1997; see instructions for PROC MIXED) and Stata (Stata Corp. 2008; see User's Guide).

7.5.4 Sensitivity analyses

Cost models invariably require the researcher to make assumptions, as when using non-VA costs as proxies for VA costs. A good practice is to carry out sensitivity analyses in which the assumed values are raised or lowered by a nontrivial amount. If the final result is not particularly sensitive to these variations, then the result gains in credibility.

7.5.5 Overfitting

A second type of sensitivity analysis concerns the fit of the model. Regression models attempt to fit the data according to specific criteria, such as the sum of squared errors for OLS. There is a danger that they will "overfit" the data so that the regression coefficients would change considerably if a different data set were used. If enough data are available, it is good practice to set aside a portion of the original data (20-35% is typical) and then estimate the original model on the remaining data. The regression coefficients are used to predict values for the data set aside. If the fitted values are close to the real values, then the original model is not overfitted. For a rigorous and thorough example, see Blough et al. (1999)

8. Hidden VA Costs: Capital and Malpractice Expense

Two costs of the VA healthcare system are borne by other federal agencies: financing capital acquisitions and malpractice liability. This chapter discusses available information on these hidden costs of VA healthcare.

8.1 VA Capital Costs

Capital--the cost of buildings and equipment--is an important part of healthcare costs. In 1997, capital payments made up 11.1 percent of the Medicare payments to U.S. hospitals covered by the Prospective Payment System (ProPAC, 1997). Economic analysis must consider this cost, which includes both depreciation and financing. VA accounting of assets only considers the purchase price, not the cost of financing a purchase. This is because the financing cost is borne by another Federal Agency. VA calculates the depreciation of assets, but does not estimate the cost of financing their acquisition. The U.S. Treasury Department sells bonds to raise money to make these purchases. The treasury pays interest on these bonds, an economic cost that should not be ignored.

The VA budget for major capital purchases is separate from the medical care operating budget. VA maintains a database of capital acquisitions, called the Fixed Asset Package. These data are kept as a text file at the VA Austin Information Technology Center and periodically distributed on CD-ROM to VA financial officers. The database includes the name of the asset, when it was purchased, where it is located, its useful lifetime, the current year's depreciation, and the balance of the remaining undepreciated value. The Fixed Asset database is the source of the annual depreciation costs reported in the Cost Distribution Report (CDR) Detail File. Depreciation is not reported in the CDR Jurisdictional File (for more information on these files, see Chapter 4).

To estimate the cost of capital for a specific intervention, the analyst can estimate the rental cost of capital by finding comparable leasing costs. An equipment manufacturer can be asked for the annual cost of leasing the equipment, including the cost of maintenance support. A commercial real estate rental agency can be asked for information on the monthly cost of leasing medical office space.

A more specific method of finding the rental cost of capital requires information on the acquisition cost of the equipment, the length of its useful life, and the interest rate. The useful lifetimes for capital goods are described in the regulations of the U.S. Internal Revenue Service. These are used to calculate depreciation for taxation purposes. The lifetime of equipment generally ranges from 3 to 10 years. Buildings are depreciated over a 30 year lifetime. The real rate of return on U.S. capital has been found to be 11.5 percent (Feldstein, et al., 1983), but an equally reasonable estimate of financing cost is the interest rate on long-term federal treasury bonds.

A simple approach to find the rental cost of a single piece of equipment would be to calculate the payment on a loan to acquire the equipment over its lifetime. This could be done using the PMT

function in Excel. A nearly equivalent method that uses continuous compounding, is to apply the following formula to find the annual payments for a loan (P) as follows:

$$P = \frac{r}{\left(1 - e^{-rL}\right)} A$$

where:
A = acquisition cost of the equipment in nominal dollars
L = life time of equipment, in years
r = nominal rate of return of U.S. treasury bills (e.g. .075 or 7.5%)
e = the base of the natural logarithm (~2.71828)

Rosenheck, Frisman and Neale (1994) compared alternative valuation methods for VA capital, one based on rental rates for similar properties and another based on replacement costs. Unfortunately the methods led to very different conclusions. Across nine VA facilities, Rosenheck and colleagues found the capital cost based on rental rates to be nearly 40% lower than costs based on replacement. There is no *a priori* grounds for preferring one method to the other. A rental market for certain medical facilities may not exist, however, such as specialized surgical suites. If a rental market does not exist, then the replacement-cost method must be used.

8.2 Malpractice Costs

Malpractice liability is another cost of healthcare. VA cost databases do not include this cost.

The cost of VA malpractice liability is borne by the U.S. Department of Justice. Lawyers from the Department defend VA from liability claims. The Justice Department also pays awards to claimants who successfully pursue their claims of malpractice.

VA maintains a database of paid malpractice claims, the Tort Claims Information System (TCIS). Access to these data may be requested via the Office of the VA General Counsel. In 2000, VA paid some $63 million in claims and settlements (Table 5). In 2005, VA paid some $59 million in 448 claims and settlements. This amount is a relative small fraction of the roughly $40 billion VHA budget each year.

The amount of these claims does not include the cost incurred by the VA General Counsel and the Justice Department in defending the agency from malpractice claims. This amount may be estimated using the following logic. Individuals who file malpractice claims are represented by attorneys working on a contingency basis. The average malpractice award includes 30-35 percent for the claimant's attorney's fees. As these attorneys are paid entirely from these contingencies, these fees are sufficient to pay for attorney cost for both successful and unsuccessful claimants. If an equivalent amount is spent defending malpractice suits as is spent in filing them, then this suggests that the federal government spent $22.3 million (35% of $63.6 million) defending VA from malpractice claims in FY2000.

Table 5: Amount Paid in VA Medical Malpractice Cases, Selected Years FY1996-FY2005

Year	Administrative Settlements	Litigation Settlements	Judgments	Total
FY1996	$ 20,492,247	$ 27,830,873	$ 5,152,155	$ 53,448,275
FY2000	$ 21,200,448	$ 38,217,368	$ 4,133,004	$ 63,550,820
FY2005	*	*	*	$59,487,986

Source: VA General Counsel (1996-2000).
* Separate figures were not available for FY2005. Figures are in nominal dollars.

References

2000 Physicians' Fee Reference Comprehensive Fee Report. West Allis, WI: Wasserman Medical Publishers, 2000.

AERA (American Educational Research Association), APA (American Psychological Association, NCME (National Council on Measurement in Education). Standards for educational and psychological testing. Washington, DC: AERA, APA, and NCME, 1985.

ADA (American Dental Association). American Dental Association 1999 Survey of Dental Fees. Chicago, IL: ADA, 2000.

Anderson G, Steinberg E, Powe N, Antebi S, Whittle J, Horn S, Herbert R. Setting payment rates for capitated systems: a comparison of various alternatives. *Inquiry* 1990;27:225-233.

Arnold N. VIReC Research User Guide:VHA Pharmacy Prescription Data, 2nd Edition. Hines, IL: Veterans Information Research and Education Center, U.S. Dept. of Veterans Affairs, 2008. URL: http://www.VIReC.research.va.gov/References/RUG/RUG-Pharmacy-2nd-Ed-er.pdf (accessed December 9, 2009).

Atkinson M, Zibin S, Chuang H. Characterizing quality of life among patients with chronic mental illness: a critical examination of the self-report methodology. *American Journal of Psychiatry* 1997;154:99-105.

Bao Y. Predicting the use of outpatient mental health services: do modeling approaches make a difference? *Inquiry* 39:168-183.

Barnett PG. The cost-effectiveness of methadone maintenance as a healthcare intervention. *Addiction* 1999;94(4):479-488.

Barnett PG, Berger MS. Cost of positron emission tomography: method for determining indirect cost. HERC Technical Report 5. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2003. [‘2003a’]

Barnett PG, Berger MS. Indirect costs of specialized VA mental health treatment. HERC Technical Report 6. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2003. [‘2003b’]

Barnett PG, Chen S, Boden WE, Chow B, Every NR, Lavori PW, Hlatky MA. Cost-effectiveness of a conservative, ischemia-guided management strategy after non-Q-wave myocardial infarction: results of a randomized trial. *Circulation* 2002;105:680-684.

Barnett PG, Chen S, Wagner TH. Determining the cost of VA care with the average cost method for the 1993-1997 fiscal years. HERC Technical Report #1. Menlo Park, CA: Department of

Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2000.

Barnett PG, Garber AG. The cost of VA-sponsored research. *Academic Medicine* 1996;71(10): 1074-1078.

Barnett PG, Lin P, Wagner TH. Estimating the costs of cardiac care provided by the hospitals of the US Department of Veterans Affairs. In: Contemporary cardiology: Cardiovascular health care economics, ed. W.S. Weintraub. Totowa, NJ: Humana Press, 2003.

Barnett PG, Swindle RW. Cost-effectiveness of inpatient substance abuse treatment. *Health Services Research* 1997;32(5):615-629.

Basu A, Manning WG, Mullahy J. Comparing alternative models: log vs proportional hazard? *Health Economics* 2004 (in press).

Bhandari A, Wagner T. Self-reported utilization of healthcare services: improving measurement and accuracy. *Medical Care* 2006; 63(2): 217-35.

Blough DK, Madden CW, Hornbrook MC. Modeling risk using generalized linear models. *Journal of Health Economics* 1999;18:153-171.

Brinker MR, Pierce P, Siegel G. Development of a method to analyze orthopaedic practice expenses. *Clinical Orthopaedics and Related Research* 2000;273:302-313.

Carey K. A multilevel modeling approach to analysis of patient costs under managed care. *Health Economics* 2000;9:435-446.

Chapko MK, Liu CF, Perkins M, Li YF, Fortney JC, Maciejewski ML. Equivalence of two healthcare costing methods: bottom-up and top-down. *Health Economics* 2009;18(10):1188-201.

Clegg, L.X., A.L. Potosky, L.C. Harlan, B.F. Hankey, R.M. Hoffman, J.L. Stanford, and A.S. Hamilton. Comparison of self-reported initial treatment with medical records: results from the prostate cancer outcomes study. *American Journal of Epidemiology* 2001;154(6):582-7.

Collins TC, Johnson M, Henderson W, Khuri SF, Daley J. Lower extremity nontraumatic amputation among veterans with peripheral arterial disease: is race an independent factor? *Medical Care* 2002;40(1 Suppl.):I-106-I-116.

Desai RA, Rosenheck RA, Rothbard A. Cross-system service use among VA mental health patients living in Philadelphia. *Administration and Policy in Mental Health* 2001;28(4):299-309.

Dillman, Don A. Mail and internet surveys: the tailored design method. Second edition. New York: Wiley, 2000.

Dominitz JA, Maynard C, Billingsley KG, Boyko EJ. Race, treatment, and survival of veterans with cancer of the distal esophagus and gastric cardia. *Medical Care* 2002;40(1 Suppl.):I-14-I-26.

[Drug Topics.] Medicaid prescription reimbursement rates by state. *Drug Topics* Feb. 9, 2004;148:98. URL http://drugtopics.modernmedicine.com/drugtopics/Supplements/Medicaid-prescription-reimbursement-rates-by-state/ArticleStandard/Article/detail/107766 (accessed Feb. 19, 2010).

Drug Topics Red Book. Montvale, NJ: Medical Economics. Various years.

DSS Program Office. Office of Finance. US Department of Veterans Affairs. FY 2004 DSS National Data Extracts (NDEs) technical guidebook. Bedford, MA: Department of Veterans Affairs, Office of Finance, DSS Program Office, 2004.

Duan N. Smearing estimate: a nonparametric retransformation method. *Journal of the American Statistical Association* 1983;78:605-610.

Dugoni B, Lee L, Tourangeau R. Report on the NLSY Round 16 Recall Experiment. National Longitudinal Surveys Discussion Paper #97-34. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics, 1997.

Dunn, G. Design and analysis of reliability studies. *Statistical Methods in Medical Research* 1992;1(2):123-157.

Ellis R, Opoe G, Iezzoni L, Ayanian J, Bates D, Burstin H, Ash A. Diagnosis-based risk adjustment for Medicare capitation payments. *Healthcare Financing Review* 1996;17(3):101-128.

Ettner SL, Frank RG, Mark T, Smith MW. Risk adjustment of capitation payments to behavioral healthcare carve-outs: How well do existing methodologies account for psychiatric disability? *Healthcare Management Science* 2000;3:159-169.

Evans C, Crawford B. Patient self-reports in pharmacoeconomic studies: their use and impact on study validity. *Pharmacoeconomics* 1999;15(3):241-256.

Feldstein M., Dicks-Mireaux L., Porterba J. The effective tax rate and the pre-tax rate of return. *Journal of Public Economics* 1983;21(2):129-158.

Fortney JC, Steffick DE, Burgess JF, Maciejewski ML, Petersen LA. Are primary care services a substitute or complement for specialty and inpatient services? *Health Services Research* 2005;40 (5 pt. 1):1422-1442.

Franke, R.H., and J.D. Kaul. The Hawthorne experiments: first statistical interpretation. *American Sociological Review* 1978;43:623-643.

Garber AM. Advances in cost-effectiveness analysis of health interventions. In: AJ Cuyler and P Newhouse, eds. Handbook of Health Economics, Vol. 1. Amsterdam: Elsevier Science, 2000.

Garber AM, Weinstein MC, Torrance GW, Kamlet MS. Theoretical foundations of cost-effectiveness analysis. In: Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.

General Counsel, U.S. Department of Veterans Affairs.

Goldberg RW, Seybolt DC, Lehman A. Reliable self-report of service use by individuals with serious mental illness. *Psychiatric Services* 2002;53(7):879-881.

Greene WH. Econometric analysis, 4th ed. Upper Saddle River, NJ: Prentice-Hall, 2000.

Grootendorst PV, Feeny DH, Furlong W. Does it matter whom and how you ask? Inter- and intra-rater agreement in the Ontario Health Survey. *Journal of Clinical Epidemiology* 1997;50(2):127-135.

Harada ND, Damron-Rodriguez J, Villa VM, Washington DL, Dhanani S, Shon H, Chattopadhyay M, Fishbein H, Lee M, Makinodan T, Andersen R. Veteran identity and race/ethnicity: influences on VA outpatient care utilization. *Medical Care* 2002;40(1 Suppl): I-117-I-128.

Hendricks AM, Lotchin TR, Hutterer J, Swanson J, Kenneally K. 2003. Evaluating VA patient-level expenditures: decision support system estimates and Medicare rates. *Medical Care* 41 (6 Suppl):II111-7.

Hughes SL, Weaver FM, Giobbie-Hurder A, Manheim L, Henderson W, Kubal J, Ulasevich A, Cummings J, and the Department of Veterans Affairs Cooperative Study Group on Home-Based Primary Care. Effectiveness of team-managed home-based primary care: a randomized multicenter trial. *JAMA* 2000;284(22):2877-2885.

Hynes DM, Joseph G, Pfeil C. The Veterans Health Information Systems and Technology Architecture (VistA) as a research tool. *VIReC Insights* 2002;3(1):1-7. Available online at http://www.VIReC.research.va.gov/HistoricalDocuments/VIReCInsights/Insights-v03n1.pdf (accessed December 9, 2009).

Ingenix. The essential RBRVS. Salt Lake City, UT: Ingenix, 2009.

Kashner TM, Suppes T, Rush AJ, Altshuler KZ. Measuring use of outpatient care among mentally ill individuals: a comparison of self reports and provider records. *Evaluation and Program Planning* 1999;22:31-39.

Kelsey, J.L., A.S. Whittemore, A.S. Evans, and W.D. Thompson. Methods in observational epidemiology. New York: Oxford University Press, 1996.

Kiernan NE, Kiernan M, Oyler MA, Gilles C. Is a web survey as effective as a mail survey? A field experiment among computer users. *American Journal of Evaluation* 2005;26(2):243-252.

Kimerling R, Street AE, Gima K, Smith, MW. Evaluation of universal screening for military-related sexual trauma. *Psychiatric Services* 2008;59(6):635-640.

Kominski G, Andersen R, Bastani R, Gould R, Hackman C, Huang D, Jarvik L, Maxwell A, Moye J, Olsen E, Rohrbaugh R, Rosansky J, Taylor S, Van Stone W. UPBEAT: The impact of a psychogeriatric intervention in VA medical centers. *Medical Care* 2001;39(5):500-512.

Kressin NR, Clark JA, Whittle J, East M, Peterson ED, Chang BH, Rosen AK, Ren XS, Alley LG, Kroupa L, Collins TC, Petersen LA. Racial differences in health-related beliefs, attitudes, and experiences of VA cardiac patients. *Medical Care* 2002;40(1 Suppl):I-72-I-85.

Leslie DL, Rosenheck R. The effect of institutional fiscal stress on the use of atypical antipsychotic medications in the treatment of schizophrenia. *Journal of Nervous and Mental Disorders* 2001;189(6):377-83.

Luce BR, Manning WG, Sigel JE, Lipscomb J. Estimating costs in cost-effectiveness analysis. In: MR Gold, JE Siegel, LB Russell, MC Weinstein, eds. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.

Lum, Gifford. Utilization and cost effectiveness of standardized testing for screening and confirmation of drugs of abuse in urine. *Annals of Clinical & Laboratory Science* 2002;32 (4):387-392.

Maciejewski ML, Chapko MK, Hedeen AN, Fortney JC. 2002. VA community-based outpatient clinics: cost performance measures. *Medical Care* 40 (7):587-595.

Manning WG, Mullahy J. Estimating log models: to transform or not to transform? *Journal of Health Economics* 2001;20:461-494.

Mathiowetz N. The redesign of the NLSY79: the impact of biannual interviewing on nonresponse and measurement error. Unpublished paper, University of Maryland, 1998.

McGinnis KA, Skanderson M, Levin FL, Brandt C, Erdos J, Justice AC. Comparison of two VA laboratory data repositories indicates that missing data vary despite originating from the same source. *Medical Care* 2009;47(1):121-4.

Medicare program; changes to the hospital inpatient Prospective Payment Systems and fiscal year 1996 rates; final rule. *Federal Register* 60(170): September 1, 1995.

Menke TJ, Homan RH, Kashner TM. Determining costs in VA: research design problems and solutions illustrated with case studies. *Medical Care* 1999;37(4 Suppl):AS18-AS26.

Meredith LS, Sherman SE, Yano EM. "Why don't we do a provider survey? Tips on conducting surveys of healthcare providers." Presentation at the U.S. Department of Veterans Affairs Health Services Research and Development Service 20th Annual Meeting (Washington, DC; February, 2002).

Miller ME, Welch WP. Analysis of hospital medical staff volume performance standards: technical report. Washington DC: The Urban Institute, 1993.

Mitchell JB, McCall NT, Burge FT, Boyce S, Dittus R, Heck R, Parchman M, Iezzoni L. Per case prospective payment for episodes of hospital care. Waltham, MA: Health Economics Research, 1995. NTIS RB95-226023.

Muennig P. Designing and conducting cost-effectiveness analyses in medicine and health care. San Francisco, CA: Jossey-Bass, 2002.

Mullahy J. Much ado about two: reconsidering retransformation and the two-part model in health econometrics. *Journal of Health Economics* 1998;17:247-281.

NDAS (National Dental Advisory Service). 2000 National Dental Advisory Service comprehensive fee report. West Allis, WI: Wasserman Medical Publishers, 2000.

Nicholson, J.M., D.J. Hennrikus, H.A. Lando, M.C. McCarty, and J. Vessey. Patient recall versus physician documentation in report of smoking cessation counseling performed in the inpatient setting. *Tobacco Control* 2000;9(4):382-388.

Nickman NA, Guerrero RM, Bair JN. Self-reported work-sampling methods for evaluating pharmaceutical services. *American Journal of Health System Pharmacy* 1990;47(7):1611-1617. Erratum in vol. 47(11):2466.

Nugent G, Hendricks A, Nugent L, Render M. Value for taxpayers' dollars: what VA care would cost at Medicare prices. *Medical Care Research and Review* 2004;61(4):495-508.

Oddone E, Guarisco S, Simel D. Comparison of housestaff's estimates of their workday activities with results of a random work-sampling study. *Academic Medicine* 1993;68(11):859-861.

Oddone E, Weinberger M, Hurder A, Henderson W, Simel D. Measuring activities in clinical trials using random work sampling: implications for cost-effectiveness analysis and measurement of the intervention. *Journal of Clinical Epidemiology* 1995;48(8):1011-1018.

Paper T, Maciejewski M, Reiber G. The National Prosthetics Patient Database (NPPD): A primary resource for nationwide VA durable medical equipment data. *VIReC Insights* 2001;2(3):1-6.

Phibbs CS, Holty JE, Goldstein MK, Garber AM, Wang Y, Feussner JR, Cohen HJ. The effect of geriatrics evaluation and management on nursing home use and health care costs: results from a randomized trial. *Medical Care* 2006;44(1):91-5

Phibbs CS, Luft H. Correlation of travel time on roads versus straight line distance. *Medical Care Research and Review* 1995;32(4):532-542.

Phibbs CS, Swindle RW, Recine B. Does case mix matter for substance abuse treatment? A comparison of observed and case mix-adjusted readmission rates for inpatient substance abuse treatment in the Department of Veterans Affairs. *Health Services Research* 1997;31(6):755-771.

Phibbs CS, Yang J, Flores NE, Barnett PG. HERC'S Outpatient Average Cost Dataset for VA Care: fiscal year 2008 update. 8th edition. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2009.

Phibbs CS, Harden C, King SS, Barnett PG. Research guide to Decision Support System national cost extracts. Menlo Park, CA: Health Economics Resource Center, U.S. Department of Veterans Affairs, 2008.

Pierret, CR. Event history data and survey recall: an analysis of the National Longitudinal Survey of Youth 1979 Recall Experiment. *Journal of Human Resources* 2001;36(3):439-466.

ProPAC (Prospective Payment Assessment Commission). Medicare and the American healthcare system: report to Congress. Washington, DC: ProPAC, 1997.

Render ML, Taylor P, Plunkett J, Nugent GN. Methods to estimate and compare VA expenditures for assistive devices to Medicare payments. *Medical Care* 2003;41(6 Suppl.): II-70-II-79.

Render ML, Nowak J, Hammond EK, Roselle G. Methods for estimating and comparing VA outpatient drug benefits with the private sector. *Medical Care* 2003;41(6 Suppl):II61-II69.

Rosen AK, Loveland S, Anderson JJ, Rothendler JA, Hankin CS, Rokovski CC, Moskowitz MA, Berlowitz DR. Evaluating diagnosis-based case-mix measures: how well do they apply to the VA population? *Medical Care* 2001;39(7):692-704.

Rosenheck R, Frisman L, Neale M. Estimating the capital component of mental healthcare costs in the public sector. *Administration and Policy in Mental Health* 1994;21(6): 493-509.

Rosenheck R, Leslie D, Sernyak M. From clinical trials to real-world practice: use of atypical antipsychotic medication nationally in the Department of Veterans Affairs. *Medical Care* 2001;39(3):302-8.

Russell LB, Siegel JE, Daniels N, Gold MR, Luce BR, Mandelblatt JS. Cost- effectiveness analysis as a guide to resource allocation in health: roles and limitations. In: Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. Cost-effectiveness in health and medicine. New York: Oxford University Press, 1996.

Sales AE, Liu CF, Sloan KL, Malkin J, Fishman PA, Rosen AK, Loveland S, Nichol WP, Suzuki NT, Perrin E, Sharp ND, Todd-Stenberg J. 2003. Predicting costs of care using a pharmacy-based measure risk adjustment in a veteran population. *Medical Care* 2003;41 (6):753-60.

Salvucci S, Walter E, Conley V, Fink S, Saba M. Measurement error studies at the National Center for Education Statistics. Washington, DC: US Dept. of Education, 1997.

SAS Institute, Inc. Mixed models theory. In: SAS/STAT® Software: changes and enhancements through Release 6.12. Cary, NC: SAS Institute Inc., 1997.

SAS Institute, Inc. SAS Procedures Guide, Version 10. SAS Institute, Inc.: Cary, NC, 2006.

Sechrest L. Validity of measures is no simple matter. *Health Services Research* 2005; 40(5 Pt. II): 1584-1604.

Sernyak MJ, Leslie D, Rosenheck R. Predictors of antipsychotic medication change. *Journal of Behavioral Health Services Research* 2005; 32(1):85-94.

Simmons SF, Schnelle JF. The identification of residents capable of accurately describing daily care: implications for evaluating nursing home care quality. *Gerontologist* 2001;41(5):605-611.

Smith MW, Barnett PG. Research guide to the VA Financial Management System. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. 2010.

Smith MW, Joseph G. Pharmacy data in the VA healthcare system. *Medical Care Research and Review* 2003;60(3 Suppl):92S-123S.

Smith MW, Cheng A. A guide to estimating wages of VHA employees – FY2008 update. HERC Technical Report 25. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. 2010.

Smith MW, Chow A. Fee Basis data: a guide for researchers. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. 2010.

Smith MW, King SS. Comparing outpatient cost data in the DSS National Pharmacy Extract and the Pharmacy Benefits Management V3.0 Database. HERC Technical Report 22. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. December, 2007.

Smith MW, Phibbs CS, Su P. VA Fee Basis data: a guide for researchers. HERC Technical Report 18. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. December, 2005.

Smith MW, Phibbs CS, Su P. Matching prosthetics order records in the VA National Prosthetics Patient Database (NPPD) to health care utilization databases. HERC Technical Report 21. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. July, 2007.

Smith MW, Velez JP. A guide to estimating wages of VHA employees. HERC Technical Report 12. Menlo Park, CA: Health Economics Resource Center, Health Services Research and Development Service, U.S. Dept. of Veterans Affairs. July, 2004.

St. Anthony's RBRVS 2000. Salt Lake City, UT: Ingenix, 2000.

Stata Corporation. Obtaining robust variance estimates. In Stata User's Guide, Release 10, ch. 20.15. College Station, TX: Stata Press, 2007.

State of California. State of California Worker's Compensation Official Medical Fee Schedule. San Francisco, CA: State of California, Department of Industrial Relations, 1999.

Sudman S, Bradburn N, Schwartz N. Thinking about Answers. San Francisco: Jossey-Bass, Inc.: 1996.

Swindle RW, Beattie MC, Barnett PG. The quality of cost data: a caution from the Department of Veterans Affairs experience. *Medical Care* 1996;34(3 Suppl.):MS83-90.

Thompson CP, Skowronski JJ, Larsen SF, Betz AL. Autobiographic memory: remembering what and remembering when. Mahwah, NJ: Lawrence Erlbaum, 1996.

Torrance GW, Siegel JE, Luce BR. Framing and designing the cost-effectiveness analysis. In: Gold MR, Siegel JE, Russell LB, Weinstein MC, eds. *Cost-effectiveness in health and medicine.* New York: Oxford University Press, 1996.

Tranmer JE, Guerriere DN, Ungar WJ, Coyte PC. Valuing patient and caregiver time: A review of the literature. *Pharmacoeconomics* 2005;23(5):449-59.

U.K. Department of Health. NHS Trust-based Patient Surveys: inpatients – acute hospitals. 2002. URL http://www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsStatistics/DH_4003171 (accessed December 9, 2009).

Valenstein M, Eisenberg D, McCarthy JF, Austin KL, Ganoczy D, Kim HM, Zivin K, Piette JD, Olfson M, Blow FC. Service implications of providing intensive monitoring during high-risk periods for suicide among VA patients with depression. *Psychiatric Services* 2009;60(4):439-444.

Wagner TH. HERC's station level cost dataset, FY2000-FY2007. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2009.

Wagner TH, Chadwick G, Cruz AME. The cost of operating institutional review boards (IRBs) in the VA. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2002.

Wagner TH, Chen S. An economic evaluation of inpatient residential treatment programs in the Department of Veterans Affairs. *Medical Care Research and Review* 2005;62(2):187-204.

Wagner TH, Chen S, Yu W, Barnett PG. HERC's Average Cost Datasets for VA inpatient care FY1998-FY2008. Menlo Park, CA: Department of Veterans Affairs, Health Services Research and Development Service, Health Economics Resource Center, 2009.

Wagner TH, Chow A, Yu W, Barnett PG. Researchers' guide to the DSS Monthly Program Cost Report (MPCR). HERC Guidebook. Menlo Park, CA: Health Economics Resource Center, U.S. Department of Veterans Affairs, 2006.

Wagner TH, Barnett PG. HERC's Average Cost Datasets for VA Inpatient Care FY1998 - FY2008. Menlo Park, CA: Health Economics Resource Center, U.S. Department of Veterans Affairs, 2009.

Waters H, Abdallah H, Santillan D. Application of activity-based costing (ABC) for a Peruvian NGO healthcare provider. *International Journal of Health Planning and Management* 2001;16(1):3-18.

Wu LL, Martin SP, Long DA. Comparing data quality of fertility and first sexual intercourse histories. *Journal of Human Resources* 2001;36(3):520-555.

Yu W, Barnett PG. Reconciliation of DSS encounter-level National Data Extracts with the VA National Patient Care Database: FY2001-FY2002. HERC Technical Report No. 9. Menlo Park, CA: Health Economics Resource Center, U.S. Department of Veterans Affairs, 2003.

Yu W, Ravelo A, Wagner TH, Phibbs CS, Bhandari A, Chen S, Barnett PG. 2003. Prevalence and costs of chronic conditions in the VA health care system. *Medical Care Research and Review* 60 (3):146S-167S.

Appendix 1 Alternative Method of Estimating the Average Cost per DRG

Below we present another method for estimating the average cost per DRG for VA care. (The term 'DRG' will be used to represent both traditional DRGs and the newer MS-DRGs in use since FY2008.) It represents an alternative to the pricer application described earlier. It assumes that the DRG is known and that cost is proportional to the Medicare DRG weight. It is better than a method based on length of stay because DRGs explain more of the variation in cost than does length of stay. Like the pricer approach, this method does not estimate the cost of physician services.

What can be done if the DRG is not available? If it is known whether the stay involved surgery then the analyst could apply the discharge-weighted mean DRG weight for surgical DRGs or non-surgical DRGs, whichever is appropriate. An alternative would be to find the average cost per day of stay and apply this to LOS.

The method relies on MEDPAR data from CMS, the federal Centers for Medicare and Medicaid Services. The data can be downloaded for free. This method can be used with the older DRG system or the newer MS-DRG system; for convenience we will refer to both as 'DRG' below.

Step 1. Find average covered charge per discharge
Visit the CMS web site (www.cms.hhs.gov) and search for 'MEDPAR'. Two sets of files will be of interest:

* annual summary by DRG: shows for each DRG the annual totals for charges, covered charges, Medicare reimbursements, days (i.e., length of stay), number of discharges, and average days

* DRG description: gives a brief description of each DRG (through FY2007) or MS-DRG (FY2008 and after)

Divide the sum of total covered payments by the sum of discharges to determine the average covered charge per discharge.

Step 2. Find average DRG weight per discharge
Visit the CMS web site and click on Medicare, then Acute Inpatient PPS (under Medicare Fee for Service Inpatient), then Acute Inpatient – Files for Download. Search for "final rule case mix." Open the resulting document.

Divide the column sum of transfer-adjusted case mix by the column sum of transfer-adjusted stays to find the average DRG weight per stay.

Step 3. Find average covered charge per DRG weight

Divide the result of step 1 by the result of step 2 to find the average covered charge per DRG weight.

Using data on the CMS web site (December 16, 2009) we found the following for FY2009:
Step 1: average covered charge per discharge was ($110,238M/13.604) = $8,103.
Step 2: average DRG weight per stay was (16.658M / 11.072M) = 1.5045.
Step 3: average charge per DRG weight was ($8,103 / 1.5045) = $5,386.

As some discharges are excluded from the DRG report to avoid disclosing patient data, this figure represents an upper bound on the cost.