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Assigning Resources to Health Care Use for Health Services Research: Options and Consequences

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Abstract

Aims—Our goals are threefold: 1) to review the leading options for assigning resource coefficients to health services utilization; 2) to discuss the relative advantages of each option; and, 3) provide examples where the research question had marked implications for the choice of which resource measure to employ.

Methods—Three approaches have been used to establish relative resource weights in health services research: a) direct estimation of production costs through micro-costing or step down allocation methods; b) macro-costing/regression analysis; and, c) standardized resource assignment. We describe each of these methods and provide examples of how the study question drove the choice of resource use measure.

Findings—All empirical resource-intensity weighting systems contain distortions that limit their universal application. Hence, users must select the weighting system that matches the needs of their specific analysis. All systems require significant data resources and data processing. However, inattention to the distortions contained in a complex resource weighting system may undermine the validity and generalizability of an economic evaluation.

Conclusions—Direct estimation of production costs are useful for empirical analyses, but they contain distortions that undermine optimal resource allocation decisions. Researchers must ensure that the data being used meets both the study design and the question being addressed. They also should ensure that the choice of resource measure is the best fit for the analysis.

Implications for Research and Policy—Researchers should consider which of the available measures is the most appropriate for the question being addressed rather than take ‘cost’ or utilization as a variable over which they have no control

Keywords

Utilization; costs; expenses; outputs; inputs; economics; health care cost; health services research; cost allocation

Introduction

Empirical health services research literature has paid too little attention to how health care resources should be identified, measured, and monetized. A great deal of consideration is given to the statistical issues associated with estimating the relationships of interest in

economic and cost analyses.¹⁻⁵ An analysis, however, is only as good as the data on which it is based. The most frequent methodological error is assuming that any dollar-valued variable is equivalent to costs of production, even to the point of treating prices charged for outputs as production costs. Indeed, many analyses do not define the relevant output or acknowledge the need to create a conceptual model that specifies the inputs used to create the defined primary output(s). Most analyses, moreover, do not address the problem surrounding multiple common and joint outputs that typically accompany health services (*e.g.*, treating multiple co-morbidities). Failing to account for the interaction among inputs will impact estimates of the cost of care and may lead to confounded research results and erroneous conclusions in economic evaluations of health care interventions and programs.

Two leading factors account for the relative lack of attention given to how resource use is measured for health services research. The first is analysts' belief that they do not have a choice in how resource use can be measured given that they frequently only have poor-quality data available for research and that use and cost data are often extracted from existing sources, rather than as independently collected primary data. The second is the belief that alternative-resource use measurements are unlikely to affect study results. Although researchers often work with data that have one or more variables labeled "cost," or "charges," or "expenses," the research question should always serve as the guide for how resource use should be defined. How one defines and measures the key cost/resource intensity concept is critical to the study design and outcomes.

This paper discusses the options that are usually available to define, measure, and potentially monetize resource use when conducting economic evaluations using encounter, claims, and/or clinical data. A large body of literature has explored the challenges of assigning costs to the resources used to produce health services as well as proposing specific methods based on available data. For example, Barnett⁶ reports on the extensive work done within the US Department of Veterans' Affairs and Ritzwoller, et al⁷ report on a similar effort among the integrated health care delivery systems of the HMO Research Network. Our goal is not to replicate the work of Barnett, Ritzwoller and others that have been able to more comprehensively examine the details related to the assignment of dollars to health care use but to offer a guide as to the how the research question should inform the measure of resource use.

Options for Assigning Resource Use to Health Care Services

Methods for establishing resource use in health services research fall into three major groupings: a) direct estimation of production costs including micro-costing and step-down allocation; b) standardized resource assignment, and c) macro-costing/regression analysis. We describe each of these methods, offer a guide as to when one measure may be more appropriate than another and provide examples of how the study question drove the choice of resource use measure.

Direct Estimation of Production Costs

Direct estimation of production costs establishes the specific fixed inputs [*e.g.* the physical capacity of clinic and hospital buildings and diagnostic equipment] and variable inputs [*e.g.* physician and non-physician labor and supplies] used to produce defined health services at an identified setting and time and, through a unit cost assignment, allows for the calculation of the total resources needed to produce a specific good or service.^{8,9} This approach provides the most accurate assessment of health services delivery cost, but is rarely done because the data required for these analyses are not available. Therefore, health services researchers commonly use either micro-costing or step-down allocation methods to generate production costs.

Micro-costing and Activity Based Accounting—Detailed presentations of micro-costing theory and activity based accounting (ABA) techniques^{10,11} for estimating the burden of illness and as inputs into cost effectiveness analyses appear elsewhere in this issue in papers by Frick¹² and Barnett.¹³ Micro-costing and ABA, henceforth referred to as micro-costing, involve the measurement of the quantity and unit cost for all of the fixed and variable inputs, examples of which are provided above, used to produce a specific and well-defined output. Micro-costing is the most appropriate costing method for studies that focus on variations in production activities, input purchasing practices, and relative production efficiencies across multiple firms and/or across multiple departments/plants in a multi-product or multi-plant firm.

Micro-costing is used most often in economic evaluations of randomized controlled trials of therapeutic interventions and in non-experimental health program evaluations. It can provide an assessment of each input's impact on the production of a specific good or service and is valuable for studies that depend on a detailed accounting of each input's specific contribution to production. This allows for analyses of the sensitivity of cost estimates to each distinct input. By varying input quantities or unit costs, one can examine alternative cost estimates for any production process.

Micro-costing has three potential weaknesses. First, these methods are labor intensive because they require a detailed accounting of the specific way in which resources are organized to produce health services. Second, the validity of a micro-cost model depends on the conceptual rigor applied to defining the opportunity cost elements to be counted in the model. Finally, a micro-costing exercise is specific to a single observed production process, environment, scale and time. Although analysts examine the sensitivity of micro-costing estimates to the impact of site specific cost estimates, baseline parameters for models are influenced by the idiosyncratic choices made by specific organizations.

Step-down Allocation Models—Step-down allocation models are commonly used within integrated care delivery systems, private managed care systems, and hospital-based networks.^{7, 14–15} These systems often have capitated revenue streams or do not bill external payers for some or all of their services. Thus, service delivery is not tracked with the same bill-generating precision as that provided by stand alone medical clinics or health centers.

Step-down cost models calculate average costs for specific periods of time for delivering services, such as physician office visits or medications using standard financial accounting reports. The allocation begins with a global budget captured on a general ledger, which includes all fixed and variable costs associated with service delivery. Individual services are then assigned relative weights based on the degree to which fixed and variable resources are required to produce them. Costs are then allocated to specific procedures or services through a cascading process that allocates each dollar spent based on the amount of physician and other labor and the physical space and equipment used to provide that service. In this way, every dollar spent is allocated, although the 'cost' of any particular service will change from time to time as the number and intensity services vary.

Step-down models are well suited for assessing the relative impact of fixed versus over-head costs because they are built on the explicit allocation of each dollar spent on service delivery to a unique end use. Step-down models provide insight into how production is organized into functional units within complex, multi-product firms because they require explicit decisions about how shared resources are allocated among multiple types of services and encounters. Step-down models also have the advantage of relying on existing financial data limiting the need for unique data collection efforts for specific research projects.

The greatest weakness of the step-down approach is that cost assignment is idiosyncratic to the organization being studied—*e.g.*, the physical plant, the staffing mix, product lines, management model, information and other production technologies. These factors are historically set and a particular intervention entails incremental changes to a subset of the inputs. The model distributes actual incurred expenses within the organization, and thus reflects the unique cost structure of that organization. While this is an ideal outcome for research focused on a single organization, it limits the generalizability of study findings related to specific costs of unique services or encounters.

Standardized Resource Use Assignment

Standardized measures do not capture the resources used in a specific setting but reflect a broader assessment of the relative resources required to deliver health care services. Standardized resource use assignment typically relies on Relative Value Units (RVUs) that are specific to each component of health services production and delivery.^{16–17} RVUs establish the relative resource intensity of health services provided by physicians and other health professionals as well as pharmaceuticals, durable medical equipment (DME), and other good and services provided as part of the health care experience. RVUs are designed to capture physician time, skill, and professional judgment required to perform a specified service.^{16–17}

Step-down models rely on RVU weights to assign costs to specific services but there is a critical difference in how the weights are used. Step-down models allocate total costs actually incurred during a period of time based on service specific weights, but the costs assigned to a particular service vary based both on total expenditures and the distribution of services. Standardized resource models apply the same weight – whether expressed in RVUs or dollars – regardless of actual expenditures.

Public and private crosswalks are available that link units of goods and services provided in health care settings to relative measures of resource use intensity. RVUs for physician services draw on Current Procedural Terminology (CPT)¹⁸ codes for which separate scales for evaluation and management (E&M), surgery, pathology, radiology related codes are available. RVUs for physician services are based on the expected physician time, skill, and risk associated with delivering services represented by the code. Inpatient services draw on Diagnosis Related Group (DRG) codes and are weighted both by the relative complexity of the services related to the diagnoses on which the DRG is based and the mean length of stay for those services. Relative values for pharmaceuticals and some DME are based on National Drug Code (NDC),¹⁹ and therapeutic class designations that often reflect mean prices paid at the wholesale level. Equipment and supplies are also identified through the Healthcare Common Procedure Coding System (HCPCS) with crosswalk to CPT codes. College of American Pathologists (CAP) units for laboratory services capture the time and capital needs typically required for processing samples.²⁰

Analysts may measure resource use through RVU values themselves or apply one of several crosswalks that attach dollars to RVUs if a study requires results in financial terms. The Centers for Medicaid and Medicare Services (CMS) provides crosswalks from RVUs for most inpatient and outpatient services and private vendors sell software that include these crosswalks. Because CMS only provides RVUs and dollar assignments for services covered by the Medicare program, analysts frequently rely on crosswalks generated by private vendors that fill in the gaps for CPTs, DRGs, and ancillary services not covered by Medicare and CMS.

There are a number of advantages to using RVU-based resource use assignment whether or not the choice is made to convert RVUs to dollars. First, RVU scales and fee schedules to

convert these values to dollars are readily available and are straightforward to apply to claims and encounter data. Second, because RVU-based approaches capture expected, standardized resource use rather than the costs experienced within a specific setting, they are an excellent candidate for multi-site studies that are not concerned with site specific costs. RVU-based approaches are also easily replicable because they do not require site- or study-specific information.

The greatest weakness with RVU-based approaches is that data must be collected and organized in a way that can be linked to the appropriate RVU scales. This process is often straightforward with data from claims systems that crosswalk to the RVUs on outpatient and inpatient visits, dispensed drugs, and ancillary services. A well known caution is that claims based codes are often selected to maximize reimbursement so RVU assignment may yield over-estimates of actual resource use. Integrated health care systems however are less likely to capture the codes that easily crosswalk to RVUS because these systems often have capitated revenue streams and have less incentive to record data that is primarily used to generate claims and, therefore, service-based revenue. Because the coding process within integrated systems are not designed to meet the needs of external funding requirements, they are more likely to use home grown codes to identify services and encounters that meet local needs and these codes cannot be directly linked to standard RVU scales.

Macro-costing

Micro-costing or standardized resource weights are not feasible for large numbers of research questions products and providers, such as assessing the costs of treatment of various diseases across multiple medical offices and hospitals. While it is possible to track all services ordered by physicians and consumed by patients, assigning particular services to a specific diagnosis is very challenging when patients have multiple diseases at the individual patient level over thousands of patients. Moreover, a particular input may improve the chances of recovering for one or more diseases and impede recovery for another disease. To address these complexities, economists use regression modeling to estimate incremental medical care costs attributable to specified variables—specific disease, location, time period, demographic characteristic, and/or system attribute.^{21–24} The typical dependent variable for macro-costing models is total medical care cost. The independent variables in the macro-costing equation include a vector of diagnoses, socio-demographic attributes, health care system attributes, time, and organizational attributes.

Macro-costing supports estimation of marginal cost of a specific diagnosis within the context of multiple co-morbidities. Regression models can also account for interaction effects among multiple diseases not captured by cost accounting or actuarial models to enable testing whether specific diseases interact with co-morbidities to increase resource use and costs. It also enables testing of whether specific diseases may interact with age, gender, and address in determining resource use and costs. Macro-costing is not equivalent to direct estimation of production and cost functions because the typical macro-costing models are too aggregated to meet the rigorous requirements for production or cost functions. Moreover, variations in the costs of physical and human resources are not measured, so their effects are loaded into the disease coefficients to the extent they are correlated. Macro-costing is useful when one has observations on unallocated total expenses and detailed information on health services. This technique employs variations over patients in their disease mix and resource use to reveal aggregate associations between specific conditions and expenses and is useful for generating estimates of the direct burden of illness and the relative costs of services provided by different clinical units. It cannot yield precise estimates required for detailed management of patients or services.

CHOOSING A MEASURE OF RESOURCE USE

Several aspects of the study design and the research objective should guide the resource measure used in health services and economics analyses. Several factors that should be considered are:

Nature of the Study

Analysts conducting cost effectiveness/utility studies should consider direct estimation of production costs or standardized resource use because either approach allows researchers to isolate the costs of specific aspects of either service delivery or outcomes. Cost effectiveness typically requires detailed assessments of the costs of intervention components along with specific links to outcomes. Macro-costing is a good candidate for burden of illness studies, particularly when multiple disease or illness states are under examination because the issue facing analysts is not isolating the cost of specific services but rather broader resource allocations across populations.

Audience/Analytic Perspective

Researchers are often advised to conduct studies from a societal perspective and present data to inform the broadest possible audience, many questions require the more narrow perspective of a specific payer or health care delivery system. Standardized resource use measures will be the most appropriate for analyses adopting a social perspective but may not inform decisions within specific settings where micro costing using site specific resource measures are likely to be the most relevant.

Internal vs External Validity

The direct estimation of production relationships has both the greatest internal and external validity because this method describes the specific process that produces health services and allows for replication in other settings with different mixes of inputs and outputs. Micro-costing and activity based accounting can also provide this degree of confidence as long as the data are reported in sufficient detail. Studies that rely on step down models exhibit significant internal validity because cost allocation models are idiosyncratic to the specific setting and may not be generalizable to settings with different input mixes. Standardized resource assignment, whether in RVUs or through a dollar-based crosswalk are externally valid when the analysis is conducted from the payer's perspective, but are unlikely to reflect a specific provider's cost of producing health services.

Time Period included in the Study

Standardized measures may be less appropriate for studies that span several years because the CPT codes that drive cost assignments and the dollar assignments attached to reimbursement change over time, which significantly increases data management concerns. More importantly, standardized measures may not reflect the impact that changing technology has on both the distribution of service provided and cost. Therefore, micro-costing is a better choice for studies covering longer periods of time.

Data Source

Data will always be the binding constraint when designing analyses and very often the level of detail that one would like in order to design the optimal study is simply not available.

EXAMPLES

We review three projects to demonstrate how the choice of resource use measure was informed by the best fit for the research question. These examples are drawn from research conducted within Group Health Cooperative (GHC), an integrated health care delivery system with over 550,000 enrollees in Washington State and Idaho,¹⁴ with 100,000 people receiving care through a contracted network. To manage the financial, clinical, and health services for this mixed model system, GHC built the capacity to simultaneously measure and assess resource use through each of the approaches discussed above. This allows analysts to select the resource use measure that is most appropriate to the study question, making GHC an ideal environment to demonstrate how to match the measurement and design issues for health services research. The three research questions we review are:

- Economics of the 'Medical Home' Model of Primary Care Delivery
- Incentives to Improve Physician Productivity
- Estimating the Cost of Chronic Illness

Economics of the 'Medical Home' Model of Primary Care Delivery

The Medical Home is a new paradigm for care delivery that creates a team-based approach to health care within the traditional primary care environment.^{25,26} The Medical Home's guiding principle is that the relationship between a patient and his or her personal physician is the basis for successful health care, and that all health and preventive services should be centered on this relationship. The physician leads a team that is responsible for coordinating and integrating all patient care and is the point of contact for all patient health care needs.

GHC implemented the Medical Home model within one of its 25 owned primary care clinics to evaluate its impact on staff and patient satisfaction, clinical and service quality, and cost of care to assess the potential for system wide implementation and to inform the national discussion about the value of this care delivery model. The evaluation addressed several design issues related to the non-random choice of a single experimental site for examining the effect of the care model both for implementation within GHC and other practices and systems considering adoption, specifically that clinics are free to organize care and services to meet the needs of the patients, which impacts both fixed and variable costs and the clinic chosen for the experiment is among the majority of GHC facilities that are not co-located with either specialty or urgent care centers.

The study design required that the Medical Home's economic impact be reported in dollars, therefore, resource use could not be measured through RVUs. Because the clinic chosen for the experiment was not representative, macro-costing models and standardized fee assignment did not seem appropriate because they would not allow the study team to identify idiosyncratic costs related to the clinic chosen for the experiment, or might mask the relationship between clinic characteristics and the Medical Home.

Between the two production cost methods, we determined that micro-costing was the appropriate choice for the study. Step-down methods allow the analyst to examine the costs for discrete components of care, but do not isolate unit costs for specific services. Micro-costing allowed us to examine the costs for each specific service and track total and relative resource use over time so that both overall resource use and the distribution of service delivery could be examined in the study clinic, relative to other parts of the delivery system. This approach supported joint hypothesis tests both of the change in costs over time and the manner in which costs change to determine if the medical home model succeeded in emphasizing the role of the patients primary care team.

Incentives to Improve Physician Productivity

To encourage more efficient delivery of primary care services, GHC changed how primary care physicians are compensated, moving from a 100% of guaranteed salary to a variable compensation method.²⁷ Beginning in April, 2003, primary care physicians, which includes Family Practice, General Internal Medicine, Pediatrics and Physician's Assistants, receive 80% guaranteed base salary plus additional variable compensation up to 120% of the guaranteed base. The bonus was determined by individual physician productivity (number and intensity of patient encounters). We tested the hypothesis that these changes increased physician productivity measured as both the quantity and intensity of services.

Data were collected on all physician services over a 10 year period, including 8 years before and 2 following the payment model change that identified the all encounters, associated diagnoses and procedures, along with the characteristics of patient panels for all GHC physicians, during that time.

Ideally, we would calculate production costs a production function or micro-costing that would isolate the impact of the compensation model during each time period. However, information about non-physician personnel and the physical plant in which physicians worked was only available for the most recent year. Therefore, identifying the specific relationship between how physicians were paid and their level of effort was not possible. The lack of data on other inputs also ruled out the use of macro-costing.

Standardized prices could be attached to each encounter, which would establish the total dollars paid in a fee-for-service environment to determine if effort was affected by the incentive payment model. This process would monetize work effort and would accurately reflect the quantity of services. However, standardized pricing may not reflect whether relative effort measured both the amount and intensity of services were altered in response to the incentive pay model. Standardized fee schedules account for changes in reimbursement over time but are not sensitive to actual medical cost inflation or how effort may change in response to the different incentives providers may face from year to year.

The research question led to use of relative value units given data constraints, specifically the work RVUs that capture the unique physician contribution to service delivery. Measuring resource use through RVUs allows for the simultaneous assessment of the quantity of encounters and services and the physician effort attached to those services. Along with measures of encounters it allows for assessment of tradeoffs between more rather than more intense services. RVUs are relatively stable over time so the analysis could assess changes in productivity over time and can be converted into dollars using weights that are unique to any setting or those provided by CMS or other payers.

Estimating the Cost of Chronic Illness

Increasing health care costs requires the development of cost-effective care models and the consistent, logical allocation of resources. In order to allocate resources within and across health care settings, decision makers must have a complete understanding of the absolute and relative costs of diagnosing, treating and managing illness and injury. Most of the research into the direct and indirect burden of illness focuses on the cost of specific diseases or disease classes, such as cancer. Comparable data on costs attributable to common health conditions are important inputs for cost-effectiveness studies and for budgeting, monitoring, and predicting costs. Such information gap we analyzed the prevalent costs of the following chronic conditions among all adults (approximately 250,000 individuals) in Group Health: anxiety, arthritis, back and neck pain, cancer, depression, diabetes, dementia, facial pain, gastrointestinal disease, headache, heart disease, human immunodeficiency virus (HIV) infection, hypertension, multiple sclerosis, panic disorder, pregnancy and pregnancy-related

conditions, respiratory disease (asthma and chronic obstructive pulmonary disease [COPD]), and stroke.²¹ Pregnancy is included in this list because its duration qualifies it as a chronic condition (more than three months), and because it represents substantial health care services use and cost for women of childbearing age. Persons with chronic conditions were identified from records of all inpatient and outpatient utilization for a single calendar year.

We used a macro-costing approach and estimated a regression with total health care costs as the dependent variable and patient level demographic factors and dummy variables for each chronic condition as independent variables. The analysis was well suited for this macro costing approach for several reasons. First, the large numbers of persons whose experience was evaluated precluded a detailed assessment of each patient's medical record to assess the reasons for any particular health encounter and the resources used at that encounter. More importantly though is that many individuals have multiple chronic conditions, which makes parsing the costs of any specific health encounter to only one chronic condition difficult. This is true even if a health care encounter includes only diagnostic or procedural codes related to a single condition because we cannot assume that a patient with multiple chronic conditions seeks health care for only one of these at a time, regardless of what codes may be recorded, as these data do not always reflect the totality of medical need.

DISCUSSION

We have argued that more attention should be paid to the manner in which resource use is measured and applied in health services research. However, researchers do not devote as much energy to the choice of resource measure, as they spend on other variables included in models or the choice of empirical specification of those models. Given that resource use is often the outcome variable in many analyses, researchers should consider all of their options before choosing how to measure 'cost' or utilization associated with health or preventive services. Even when costs data is provided on public use data sets or from information provided by payers or insurers, researchers should ensure that resource use measure is the best fit for the analysis.

We provided an assessment of the three ways in which resource use can be measured for health services analysis as well as a guide for when one measure or another may be more appropriate given the study question, audience and data source. Researchers should consider which of these measures is the most appropriate for the question being addressed rather than take 'cost' or utilization as a variable over which they have no control to ensure that the data and the research question are aligned.

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