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Review of Methods to Determine VA Health Care Costs

PAUL G. BARNETT, PHD

BACKGROUND. Estimates of health care cost are needed to conduct cost-effectiveness research at the facilities operated by the US Department of Veterans Affairs.

METHODS. The medical literature was searched for VA studies to characterize different cost methods and identify their advantages and disadvantages.

RESULTS. Different methods are appropriate for different studies. Analysts who wish to capture the effect of an intervention on resources used in a health care encounter may wish to create a detailed pseudo-bill by combining VA utilization data with unit costs from the non-VA sector. If a cost function can be estimated from non-VA data, VA costs may be determined more economically from a reduced list of utilization items. If the analysis involves a new intervention or a program that is unique to VA, direct measurement of staff time and supplies may be needed. It is often sufficient to estimate the average cost of similar encounters, for example, the average of all hospital stays with the same diagnosis and same length of stay. Such estimates may be made by combining VA cost and utilization data bases and by applying judicious assumptions.

CONCLUSIONS. Assumptions used to estimate costs need to be documented and tested. VA cost-effectiveness research could be facilitated by the creation of a universal cost data base; however, it will not supplant the detailed estimates that are needed to determine the effect of clinical interventions on cost.

Key words: hospitals; veterans; economics; health care costs; costs and cost analysis; methods. (Med Care 1999;37:AS9–AS17)

The hospitals and clinics operated by the US Department of Veterans Affairs (VA) provided some $16 billion of health care to veterans in 1997. Because most patients are not charged for the services they receive, VA does not routinely prepare patient bills. As a result, VA does not have the detailed charge data which researchers in the rest of the US health care sector use to estimate costs.

Whereas VA keeps careful account of the funds which it spends, it has a cost-accounting system that only approximates the costs of any specific department. There is currently no system-wide information on the costs of care incurred by any specific patient, of particular programs within a department, or of specific health care products. The Decision Support System, a cost-allocation system which is being implemented by VA to fill those gaps, is discussed in another article in this supplement.

Accurate information on health care costs has a number of possible uses. It is needed to undertake cost-effectiveness analysis of new pharmaceuticals, medical and surgical procedures, and patient care programs. It is also needed to help managers determine if programs are efficient, to provide better information on resource allocation decisions, and to help VA decide whether it should make or buy specialized medical care.

Cost-effectiveness analysis requires information on the long-term incremental cost of care. An

From the Health Services Research and Development Field Program and the Cooperative Studies Program, US Department of Veterans Affairs, Menlo Park, California, and the Department of Health Research and Policy, Stanford University, Stanford, California.

Address correspondence to: Paul G. Barnett, PhD, Health Economist, HSR&D Center for Health Care Evaluation, VA Palo Alto Health Care System, 795 Willow Rd. (152 MPD), Menlo Park, CA 94025. E-mail: pbarnett@odd.stanford.edu.

analysis requires both health care cost and indirect costs incurred by patients. There are several excellent texts that describe the costs which should be measured.[1–3] The scope of this paper is limited, however, to the methods used to determine the cost of health care services in health care systems such as VA, which do not routinely prepare bills. Analysts interested in systems without billing data may also benefit from reviewing methods developed in other environments, such as the Canadian health care system.[4,5]

The cost of a health care encounter is usually estimated by counting the number of units of each of the different resources which were used in the encounter (Ui) and by multiplying by the estimated average cost (Ci) of each resource. If there are N different types of resource employed, the total cost of the encounter (TC) is given as:

$$TC = \sum_{i=1}^{N} U_i C_i$$

The most precise cost analysis would count every type of resource used in the encounter. At one extreme, the analyst would seek to count every consumable item used in a hospitalization, every minute of staff time, and all use of equipment and physical plant. Gathering detailed utilization information is expensive; there is a trade off between accuracy and practicality. The estimate should be sensitive to the effect of the intervention being studied on resource use.

This review describes six different methods for determining costs. Those methods, their advantages, and drawbacks are summarized in Table 1. They include two methods based on non-VA data: the preparation of a pseudo bill and estimates based on a cost-function estimated from clinical data. Direct measurement is a method used to determine the cost of programs that are unique to VA. The remaining three methods combine VA cost and utilization databases. The paper concludes with a discussion of assumptions used to determine VA costs, the appropriate use of each of the six methods, and a description of areas for future research.

Use of Non-VA Data to Determine Costs

VA costs may be estimated using information from non-VA sources. There are two methods. One combines VA utilization with non-VA cost estimates, an approach that is sometimes called a "pseudo bill". The other method uses non-VA data to estimate a clinical cost function.

Both methods require detailed utilization data, and they may be more sensitive than other methods as to the effect of practice patterns and patient characteristics on cost. These non-VA methods have the disadvantage of assuming that resource costs are the same in VA medical centers as they are in the non-VA sector; as a result, they may not reflect VA-specific factors that affect cost.

Pseudo-Bill. A variety of different non-VA data have been used to estimate the cost of items listed in the pseudo-bill. They include the charge rates of an affiliated university medical center,[6,7] the payment rates from a typical health care payer,[8] or the charge rates allowed by Medicare.[7,9,10]

Because the itemized list of costs is analogous to the standard fee-for-service hospital bill, it is sometimes called a pseudo-bill. When charges of a non-VA provider are used to estimate the cost of each resource, the analogy is exact. The analyst has estimated what the bill would have been if VA had used the charge schedule of the non-VA provider.

Cost-effectiveness analysis requires information on costs, but not on charges, however. The charge data can be adjusted to reflect costs, for example, by multiplying charges by a department-specific cost-to-charge ratio. A more exact alternative is to determine the average cost of each resource. When average cost data are used, the estimate is no longer a pseudo-bill but is a detailed cost estimate.

The pseudo-bill method requires correspondence between the list of items in the non-VA charge (or cost) schedule and the resources measured at VA. For example, the non-VA data may include charges for different ancillary services and the charge for a day of stay. If the VA utilization data do not include ancillary services, then the resulting estimate will be based on charges exclusive of ancillaries, understating the total charge.

Some cost analysts have sought to estimate costs with fewer measures of utilization than are needed to prepare a full pseudo-bill. One study characterized the days of hospital stay spent in general medicine, surgery, or intensive care departments and multiplied the utilization by the national average charge for each department, as determined by a study of a large number of Medicare hospitalizations.[7] Whereas superior to

TABLE 1. Methods Available to Estimate the Cost of VA Provided Health Care

Method	Source of Data	Assumptions	Advantages/Disadvantages
Pseudo-bill	Detailed utilization data Schedule of charges adjusted for cost	Schedule of charges reflects relative resource use Cost-adjusted charges reflect VA costs	Pro: Captures effect of intervention on pattern of care within an encounter Con: Expense of obtaining detailed utilization data
Cost function based on non-VA data	Previous study with cost-adjusted charges and detailed utilization Reduced list of utilization measures previously identified as important	Same as for pseudo-bill The relation between cost and utilization is the same in the current study as in the previous study	Pro: Less effort to obtain reduce list of utilization measures than to prepare pseudo-bill Con: Must have detailed data from prior study, may result in error or bias
Direct measurement	Staff activity analysis Payroll data on labor cost Estimate of supply costs	May assume all utilization uses the same amount of resources	Pro: Useful to determine cost of a program that is unique to VA Con: Limited to small number of programs, can't find indirect costs, can't find total health care cost
Average cost per inpatient day based on CDR	CDR matched to Patient Treatment File	All inpatient days have equal cost	Pro: Simple, may be accurate for psychiatric and long-term care Con: Biased for acute medical and surgical care
Average cost per DRG weight based on CDR	CDR matched to Patient Treatment File	VA use of resources for different diagnoses same as for non-VA hospitals	Pro: Avoids bias of assuming all days of equal cost, can estimate cost from administrative data Con: Not sensitive to variations among patients with same diagnosis
Average cost per clinic visit based on CDR	CDR matched to Outpatient Care File	All visits have the same cost	Pro: Can estimate cost from administrative data Con: Does not capture variation in ambulatory care cost

methods which assume that all costs are exactly proportional to length of stay, regardless of the diagnosis or services used, it is uncertain how well this method captures variation in cost.

Researchers in the United Kingdom have studied whether the number of different types of utilization measures that are measured can be reduced. One effort compared data from five studies of community and home-based psychiatric care.[11] Costs were first estimated by measuring 21 types of utilization. The five most important types of utilization accounted for more than 90% of the costs. The same items were not the most important in all of the studies, however. When a common list of five items was developed for all of the studies, fewer costs were accounted for. In one study, the items on the common list accounted for an average of just 61.1% of costs. Moreover, as residential accommodation was the most important cost in these studies, the same reduced list is unlikely to be useful for other types of health care.

Another study from the United Kingdom examined whether a short list of utilization items could estimate the cost of surgical treatment for colorectal cancer.[12] The cost of care was estimated from 14 types of utilization. Four of these items, the cost of the inpatient ward, operating theater, blood bank, and pathology departments accounted for

91.6% of total costs. However, a cost estimate based on those four items was inaccurate for some patients, especially those who had incurred costs for intensive care and procedures.

Cost-Function Estimated From Non-VA Data. A few studies have used non-VA data to estimate a cost function to explain how cost varies with resource use. Its parameters can be used to translate VA utilization data into a cost estimate, and its chief advantage is that it requires less VA data than is needed to prepare a pseudo-bill.

This method was applied to a sample of 103 VA hospitalizations.[13] An itemized pseudo-bill was constructed using the prevailing charges at a nearby private nonprofit hospital. A regression employing days, intensive care unit days, number of lab tests, and number of surgeries predicted 97.7% of the variance in those imputed charges.

The parameters from that regression were validated in a later study.[14] When used to estimate the cost of 11 patients with leukemia treated at a University hospital, the model explained 95% of the variation in hospital charges.

Patient-level cost functions may prove to be a useful way to find costs. If suitable non-VA data are available, a function can be estimated using cost-adjusted charges as the dependent variable and information about the encounter as the independent variable. VA costs could be estimated by applying the parameters from the function to VA encounter data, simulating the cost of care. This method requires the assumption that VA providers use the same quantity of resources as non-VA providers; thus, it is most appropriately used when the cost function is estimated and is applied to patients who have the same disease or who are receiving similar treatments.

A cost function can provide an accurate estimate of the costs of care with far less data than is needed to create a pseudo-bill. Accuracy would be enhanced, however, if the information used to estimate the function and to simulate costs was not limited to data from administrative data sets.

Some refinements to this method should be considered. Rare, but expensive, events make cost data highly skewed; as a result, the assumptions of ordinary least-squares regression are not appropriate. Bias would be avoided if the dependent variable was the log of costs; that functional form requires correction for retransformation bias.[15]

Direct Measures of Cost

There are a number of cost finding problems in which non-VA data cannot be used. For example, when a new intervention is developed or when a program that is unique to the VA is evaluated, there is no comparable non-VA data. In such cases, costs can be estimated by directly measuring the time spent by different staff and by determining its cost from accounting data.

The method of direct measurement has been applied to a number of VA studies, including estimates of the cost of long-term psychiatric care,[16] adult day health care,[17] geriatric evaluation and management clinics,[18] a program for the homeless and chronically mentally ill,[19] hypertension clinics,[20] other clinics,[21] mental health programs,[22,23] substance-abuse treatment programs,[24] and the cost of research.[25]

Different methods have been used to estimate the staff time. The analyst may watch staff directly to determine the time spent on different patient care activities. Fries' study of long-term psychiatric care was unique in its detail.[16] Each individual staff member kept a detailed log of activities for the week of the study, including how much time was spent on the care of each patient.

The method more commonly used is a survey of program supervisors. Respondents are asked to estimate the time that each type of staff spends on different activities. The cost of labor is then estimated from payroll or accounting records. The cost of supplies, equipment, and other expenses is also estimated.

The analyst determines program volume, usually from administrative records. Total costs are divided by total volume to find the average cost. Various units have been used to measure program productivity, resulting in average cost expressed as the cost per clinic visit, per patient contact, per patient service, or per day of stay. The calculation of average cost is usually made with the assumption that units of production are homogenous, each produced with an equal quantity of resources. That is a strong assumption that may not always prove to be true.

If units of service are not homogenous then the analysis needs to distinguish between them. There are two ways to determine average costs in this situation. The accounting approach applies an estimate of the relative cost of each service; for example, the analyst might assume that a 30-minute clinic visit requires exactly twice as many

resources to produce as a 15-minute long visit. This method is limited by information about the relative cost of the different services. The econometric approach estimates a function that explains how costs vary with the production of different services. The function is then used to estimate incremental cost. This method is limited by statistical power and by the underlying accuracy of cost accounting data.

Rosenheck discusses the problem of estimating the volume of services produced by new programs when full productivity has not yet been achieved.[22] He used program volume from the second half of his study, with the assumption this was closer to the programs' steady state.

Another issue is accounting for the cost of activities that yield more than a single product. The goal of most analysis is to determine incremental cost, which is the extra cost incurred to provide the product, holding all other production at the same level. An example is the treatment of the cost of activities that produce both patient care and medical education. The cost of activities that are exclusively attributable to education should be excluded from the tabulation of patient care cost.

The direct measurement method is useful for finding costs of the intervention or program under study but cannot always be used. Information on all health care costs would require activity reports from all departments in the medical center–the analyst would be creating a complete hospital cost report. That is beyond the resources of most studies. For this same reason, direct measurement is rarely used to determine overhead (indirect costs) such as building maintenance, administration, personnel, or housekeeping.

Cost Estimates Based on Administrative Data

In many research studies it is not possible to obtain detailed utilization information or to directly measure staff activity and cost; therefore, the analyst must rely on VA administrative data. Most VA cost-effectiveness research has relied on the Cost Distribution Report (CDR). The CDR, also termed the report RCS 10-0141, is routinely prepared by all VA medical centers. Service chiefs in each facility estimate how staff spend their time in different patient care departments ("cost distribution accounts"). Those estimates are used to distribute cost data in the general ledger to the different patient care departments of the medical center.

The CDR also reports units of production and unit costs of each department. The unit costs are the average cost per day of stay for inpatient departments and the average cost per visit for outpatient clinics. CDR unit costs have been widely used to estimate VA costs.

It is unwise to rely on the CDR for information about a particular patient care department in a particular facility without undertaking some sort of validity check.[26] One practical difficulty in working with the CDR is the fact that overhead (indirect cost) is not distributed to specific departments. This can be done only by making an assumption that overhead should be distributed in proportion to units of utilization or that it should be distributed in proportion to direct costs. The validity of either basis has not been evaluated.

The unit costs reported in the CDR are sometimes in error because of the imperfect match between utilization and cost data. Some utilization cannot be matched to a department and is dropped from the report. In other cases, the CDR identifies costs, but not utilization, and the unit costs for that department are reported to be zero.

A better approach is to use utilization data from the VA discharge (the Patient Treatment File) and ambulatory care data bases (the Outpatient Care File). As a patient care department is not defined in the same way in the utilization files as in the CDR, departments must be aggregated to find a common denominator. Data must be matched on a temporal basis as well. The CDR reports costs incurred during a single fiscal year. The discharge data in the Patient Treatment File reports on all patients discharged during the fiscal year; some of those hospital stays began before the onset of the fiscal year, whereas other stays that began during the fiscal year are not yet complete. To assess the number of days of stay that occurred during a given fiscal year, days that occurred before the beginning of the fiscal year must be excluded. The VA hospital census provides reports of the days of stay incurred by patients who remain in the hospital on the last day of the fiscal year.

When CDR data have been matched to utilization data, the average cost can be found by dividing the total cost in the CDR by the units of utilization reported in the administrative data. The VA Allocation Resource Center has created a data set that includes both cost and utilization data. That is a potential source of data that might be used to derive

average cost. Users should be cautious about that data source, however. To be useful to the VA budget process, this data set is constructed rapidly using preliminary cost data. Final data, and even programming errors, are not subsequently corrected. The total costs in this data set do not equal the total cost in the CDR, even though the CDR is the basis of its cost estimates.

Average Cost Per Day of Stay Based on the CDR. The average cost of a day of hospital stay has been used to estimate the cost of stays in intensive care units,[27] as well as in surgical and medical departments.[18,20,28,29] Average daily costs have also been used to find the cost of psychiatric and long-term care stays.[18,29–32]

Most analysts assume that each day of hospital stay costs exactly the same. There is considerable evidence, however, that the cost of a day of acute medical and surgical care depends on the diagnosis, and that daily costs decline as the stay progresses.[33] Patients incur twice as many costs on the first day of a hospitalization as they do in later days. The assumption that the cost of an acute hospital stay is proportional to its length may lead to cost estimates that are quite biased.

Average Cost Per DRG Weight Based on the CDR. Diagnosis provides more information about the cost of a hospital stay than does the length of stay. The system of Diagnosis Related Groups (DRGs) categorizes hospital stays by diagnosis. A measure of the relative charges incurred by Medicare patients within each DRG is published annually by the Health Care Financing Administration and is termed the DRG weight.

The DRG weight explains more of the variation in the cost of acute hospital stays than does the length of stay. A study of cost adjusted charges of Medicaid eligible men in California who were between 21 and 64 years of age found that DRG weight explained 30.1% of the variation in cost, whereas length of stay explained only 17.9%.[34]

One method used to incorporate diagnosis into cost estimates has been to use non-VA data to find a different daily cost rate for each DRG. That method was applied to study hospital costs incurred by subjects in a trial of adult day health care.[17] Such an approach will yield cost estimates that are more accurate than those based on length of stay alone, but it retains the strong assumption that all days of hospitalization within a given DRG have the same cost. As the days at the beginning of a hospitalization are more expensive, this method understates the cost of shorter stays and overstates the cost of longer stays.

This assumption can be avoided. Cost may be estimated as the mean cost of the DRG, adjusted for the difference between the patient's observed length of stay and expected length of stay (that is, the mean length of stay for all VA patients in that DRG). The cost of those marginal days, which are less than the average cost over the entire stay, may be estimated statistically.

Such a method has been applied directly to VA data[34] and assumes that VA costs are proportional to the HCFA DRG weight. A cost function was estimated using the average cost per discharge as the dependent variable. The independent variables included the average DRG weight, the quantity of medical education and research, an index of the geographic variation in wages, and the department size. An additional independent variable was the average difference between the length of stay and the expected length of stay. This method relies on an implicit cost function, HCFA's method of calculating the DRG weight, and the assumption that the marginal days of stay beyond the mean for the DRG always have the same cost. A refinement to this method might use non-VA data to estimate DRG weight and a DRG-specific cost for marginal days.

DRGs do not explain much of the variation in the costs of psychiatric hospitalization or long-term care; for this reason, specialty facilities were exempted from the Medicare prospective payment system. It may be appropriate to assume that the cost of this type of care is proportional to length of stay.

Patient characteristics can be used to estimate the average daily cost of long-term care patients. VA regularly evaluates nursing home patients to assign them to a Resource Utilization Group, a case-mix measure that reflects the relative cost of long-term care.[35] That data is available and can be used to develop daily cost estimates that reflect the acuity of the long-term care patient.[34]

Length of stay appears to be the best available measure of the resources used in psychiatric hospitalization. The fixed costs associated with a psychiatric hospitalization suggest that the first day of stay, in which the patient undergoes evaluation and assessment, may be the most expensive. There is, however, limited evidence that this is true. A comparison of short and long stays in VA psychiatric units found that less labor was needed to care for long-term patients.[16]

Average Cost Per Visit Based on the CDR. Average cost per visit has been used to characterize the cost of outpatient care.[28,30] VA cost studies have frequently employed the assumption that all visits to outpatient clinics use the same quantity of resources. A measure of relative cost of different clinic visits has been estimated econometrically,[34] but VA databases do not provide sufficient power to provide a very precise estimate.

Analytic Assumptions Used to Estimate Costs

Simplifying assumptions can make it possible to estimate costs. Analysts must, however, clearly articulate the assumptions made and justify their use.

Cost Based on a Single Facility or the National Average. Estimates of the cost-effectiveness of an intervention are sometimes based on the cost of a single facility under the assumption that its costs are typical. A few studies have used local facility costs in part of their estimate and national average costs for other parts of the estimate;[31,36,37] that simplify cost finding, but the assumption that local costs are typical must be justified. For example, if the facility is in a geographic area that has low wages, the cost of the intervention may be underestimated.

Overhead Cost. Some analysts have excluded overhead costs. One study included overhead in measuring the cost of standard care but excluded it from the cost of the intervention.[38] Such an approach is biased; the analyst needs to make consistent assumptions when determining costs. The exclusion of overhead costs may be appropriate for a short-run, management-oriented analysis. Most cost-effectiveness analysis requires a long-run perspective and should consider the long-term incremental cost. As all costs are variable in the long run, overhead costs are ordinarily included.

Charges and Cost. Some studies have used health care charges as a proxy for costs. As charges are generally higher than costs, that approach may be used only if the analysis can show why results are unlikely to change if charges were adjusted for costs. One study used charges and costs interchangeably.[9] Such a practice may lead to problems.

Changes Over Time. Studies that consider trends in health care costs must consider changes in both the unit costs and utilization. A study of five-year trends in mental health care considered changes in utilization but used the same average daily rate to estimate costs.[29] The assumption that the average daily cost of care did not change over the period may not be warranted.

Capital Cost. Most analysts who use the CDR have assumed that it adequately represents the cost of capital. The CDR includes building and equipment depreciation but not the cost of financing interest. One analysis of mental health costs used two different measures of capital cost: the replacement value of facilities and the rental value of comparable facilities.[39] The findings were the same, regardless of the measure used, as capital was a small part of the cost of the programs studied.

Research and Education Cost. Most analysts have not made it clear whether their CDR cost estimate excludes research and education costs. The CDR appears to overstate those costs.[25] If the cost estimates exclude them, they will understate the cost of patient care. Only costs which are strictly attributable to research and education and which involve no patient care activities should be excluded from an estimate of the incremental cost of patient care.

Physician Cost. The VA cost data base includes physician costs. Hospital discharge data from other sources, including Medicare and state hospital disclosure reports, do not report physician costs. Cost estimates must include physician costs and treat them consistently.

Total Health Care Costs. A number of VA studies have measured the direct cost of an intervention without considering its other effects on health care cost.[8,9,40] That approach assumes that those others costs are negligible; such assumptions should be explicitly stated. Even if the difference in the total health care cost incurred by subjects in the intervention and control groups is not estimated, the assumption that they can be ignored may be tested by comparing utilization rates, including rates of hospital readmission, length of stay, and utilization of ambulatory care.

Discussion

The methods presented in the review are summarized in Table 1. They differ according to the trade-off between the expense of gathering detailed information to make a cost estimate that reflects all of the variation in resources used in an encounter and of the economy that can be achieved by estimates based on less data and judicious as-

sumptions. A detailed method, such as the pseudo-bill or the direct measurement method, is needed to determine the effect of an intervention on resources used within an encounter. If an estimate based on the average cost of similar encounters can be used (eg, the average cost of a hospitalization given the DRG and length of stay), a simpler method may be used.

Each method may be appropriate, depending on the context. Indeed, a single study may adopt both approaches, applying the detailed estimates to determine cost of encounters in which the intervention is delivered and using simpler methods to estimate the cost of subsequent health care utilization.

Cost methods need to be tested and improved. Research is needed to compare the different methods. For example, the cost of substance-abuse treatment programs estimated from the CDR was found to correlate moderately well with a direct measure of staff cost that was based on a survey of program directors and on national average staff costs from the general ledger.[24] Additional work of this type is needed to determine whether cost-effectiveness findings are sensitive to the methods employed.

Cost methods must be designed so that they are sensitive to the effect of the intervention. For that reason, the development of a single-cost method that can be applied to all studies is unlikely.

A standard VA cost data set would relieve VA researchers of the burden of estimating standard costs for health care. That data set could provide the best estimate of the cost of patient-care encounters based on data available from the CDR and utilization files. Given current data limitations, it would require the assumption that every patient incurred the average level of cost, given their diagnosis, length of stay, and inpatient departments visited. The data set might provide two estimates of costs: one could be based on national average cost rates and the other could reflect local conditions. However, the latter estimates would not represent local variations in practice patterns or the effects of specific interventions.

The resolution of two issues would make it easier to create those standard costs estimates. Research is needed to test whether Medicare DRG weights, or DRG weights based on some other data set, are an appropriate manner in which to characterize the relative cost of acute hospital stays at VA or whether VA specific weights are needed.

Second, relative values are needed for VA outpatient visits. One potential source of information is the procedure codes being gathered as part of the new VA ambulatory-care data base. Another approach will be to study the relative cost of clinic visits estimated by VA facilities pioneering the implementation of the Decision Support System, the new VA cost accounting system.

Improvements in methods of determining cost will help VA become a more efficient health care provider and will allow it to improve its efforts in cost-effectiveness research.

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