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Use of the Decision Support System for VA Cost-Effectiveness Research

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BACKGROUND. The Department of Veterans Affairs is adopting the Decision Support System (DSS), computer software and databases which include a cost-accounting system which determines the cost of health care products and patient encounters.

OBJECTIVES. A system for providing cost data for cost-effectiveness analysis should be provide valid, detailed, and comprehensive data that can be aggregated.

METHODS. The design of DSS is described and compared with those criteria. Utilization data from DSS was compared with other VA utilization data. Aggregate DSS cost data from 35 medical centers was compared with relative resource weights developed for the Medicare program.

RESULTS. Data on hospital stays at 3 facilities found that 3.7% of the stays in DSS were not in the VA discharge database, whereas 7.6% of the stays in the discharge data were not in DSS. DSS reported between 68.8% and 97.1% of the outpatient encounters reported by six facilities in the ambulatory care data base. Relative weights for each Diagnosis Related Group based on DSS data from 35 VA facilities correlated with Medicare weights (correlation coefficient of .853).

CONCLUSIONS. DSS will be useful for research if certain problems are overcome. It is difficult to distinguish long-term from acute hospital care. VA does not have a complete database of all inpatient procedures, so DSS has not assigned them a specific cost. The authority to access encounter-level DSS data needs to be centralized. Researchers can provide the feedback needed to improve DSS cost estimates. A comprehensive encounter-level extract would facilitate use of DSS for research.

Key words: hospitals; veterans; economics; health care costs; costs and cost analysis; methods. (Med Care 1999;37:AS63–AS70)

The US Department of Veterans Affairs (VA) is adopting a computerized cost-accounting system that will, for the first time, allow VA to determine the cost of specific patient care encounters. The VA Cost Distribution Report included information only on the cost of departments within a medical center and had no information on costs incurred by any individual patient.[1] The new system, termed the Decision Support System (DSS), is a set of programs that use relational databases to provide information needed by managers and clinicians. This paper considers only the cost determination function of DSS.

VA has made a substantial commitment of resources to implement DSS throughout its system of some 150 VA medical centers. Although some facilities have collected 2 or more years of data, a complete year of data from all facilities will not be available until after September 1999.

If DSS is valid and accessible, it will be a tremendous boon to cost-effectiveness research in VA. This paper begins by describing criteria to

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evaluate whether a cost-finding system like DSS can be used for cost-effectiveness research. It then describes the design of DSS and analyzes DSS cost data on hospital stays and outpatient care. The conclusion offers suggestions on how to overcome the current limitations to research use of the DSS.

Information Needed for Cost-Effectiveness Analysis

A cost-accounting system will be useful for cost-effectiveness analysis if it is valid, detailed, comprehensive, and can be aggregated. The cost-effectiveness analyst must determine the incremental opportunity cost associated with the health care decision under study. All health care costs must be considered, including the cost associated with the intervention itself and the cost of all other services, regardless of the setting in which they were provided or the facilities in which they were obtained. For this reason, the cost system must be comprehensive.

The costing system needs to provide detail on the components of patient care cost. The analyst needs to identify the cost incurred by a particular patient in a particular encounter. For example, a comparison of an experimental group to a control group requires patient-level data, so that costs of patients in each group may be tallied. Encounter-level data is needed to understand the source of differences, for example, to learn if an intervention shifts costs from the inpatient to outpatient setting. Such detail is also needed to model the long-term consequences of an intervention.

Cost estimates should include fixed costs, such as capital and administrative overhead. Analysis of the cost-effectiveness of a new health care intervention requires information on long-run costs; because the quantity of all factors used in production may be changed over the long run, fixed costs are appropriately included as part of long-run incremental costs.[2] The ideal system should, however, be able to distinguish fixed from variable cost. Short-term analysis sometimes excludes fixed costs. For example, a hospital which is deciding whether it should close its cardiac surgery unit and contract with another facility for that care should not include the capital cost of its current building; that cost has been "sunk"and won't be affected by the decision.

The analyst may need to identify the cost of specific supplies and services used in an encounter, for example, to exclude the cost of protocol-induced resource consumption. The analyst may wish to determine the cost of a hospital stay exclusive of physician services so that data will be comparable with cost data from another source (eg, non-VA hospitals).

Finally, the cost system must allow for aggregation of data. When the analyst wishes to evaluate an intervention that had widespread application, it is appropriate to use a national cost estimate. The cost of a particular facility may reflect idiosyncratic labor rates, practice patterns, or facility efficiencies. This requires a system that can determine of the national average cost of groups of patients and specific types of service.

Design of the Decision Support System

Hospital charges generally exceed the cost of providing care; it is generally agreed that unadjusted charges should not be used for cost-effectiveness analysis. Cost-adjusted charges are the traditional measure that is used, and they are found from billing data and a hospital cost report. The charges on the hospital bill are used as a measure of the relative quantity of resources used in each department. The charges incurred in each department are multiplied by a cost-to-charge ratio for that department. The cost-adjusted charges for that stay are summed over all departments:

$$RCC\ CHARGES = \sum_{i=1}^{N} CHARGE_i \left[\frac{DEPTCOST_i}{\sum_{j=1}^{J} CHARGE_{ij}} \right]$$

The cost-adjusted charges for a given hospital stay (RCC CHARGES) is the sum of the charges incurred in all N departments (CHARGE). The term in brackets is the cost to charge ratio for department i, which is found by dividing the total department cost (DEPTCOST) by the total charges incurred by all J patients who incurred charges in that department. Department costs are determined from a cost report prepared with a cost-allocation method, including a step-down method of distributing overhead. In actual practice, charge data is often not available at the department level, and analysts often use a single facility wide cost-to-charge ratio.

VA does not routinely bill its patients; therefore, no charge data is available. DSS assigns relative value units (RVU) to the products of each department. The RVU is a measure of the resources used in each department. The RVU's incurred in each department (RVU_i) are multiplied by a cost per RVU for that department. The DSS cost is found by summing these costs over all departments:

$$DSS\ COST = \sum_{i=1}^{N} RVU_i \left[\frac{DEPTCOST_i}{\sum_{j=1}^{J} RVU_{ij}} \right]$$

The term in brackets is the average cost per RVU in department i, which is found by dividing the department's cost by the total number of RVU's of service provided to all J patients who received care in that department. Department costs are determined by a cost-allocation method, including a step-down method of distributing overhead. Under DSS, it is the RVU, rather than the billed charge, which is the measure of the relative quantity of resources used in each department.

The DSS system accounts for six categories of cost-supplies, equipment, and the labor of physician, nurses, contract workers, and all other labor. The above exposition simplifies the DSS method, for DSS uses six separate RVU's, and six separate categories of cost.

DSS departments include both patient care units and units that do not produce patient care, such as teaching, research, administration, and building maintenance. DSS extracts costs from the VA payroll and general ledger. Those are assigned to departments based on periodic reports made by managers, who assign costs of the six categories to departments. Some sites use time reports and accounting data instead of managerial reports to assign costs to departments. The calculation of department costs from the managerial estimates, payroll, and general ledger data is done by the DSS program called the Account Level Budgeter (ALB).

Overhead (the cost of departments that do not produce patient care) is distributed to patient care departments using a step-down method. Direct cost or the number of square feet of occupied space are used as the basis of the distribution.

Costs of intermediate products are then determined. Examples of intermediate products are a chest x-ray, a unit of blood, a 15-minute clinic visit, or a day of stay in the intensive care unit. They are called intermediate products to distinguish them from the final product, a patient encounter which is a bundle of intermediate products.

DSS relies on the pre-existing VA data bases for information on what care was provided and which patients utilized it. The Veterans Health Information Systems and Technology Architecture (VISTA) is the means by which VA records clinical data and documents health care encounters. That system, formerly known as the Decentralized Hospital Computer Program (DHCP), includes modules that record data from laboratory, pharmacy, radiology, surgery, and other departments.[3,4] VISTA includes information from the abstract of the hospital discharge. It also records outpatient visits, including codes for the type of clinic visited, procedures, and diagnoses.

RVU's are assigned to each product based on an estimate of the relative costs of the resources needed to produce it. The department's cost per RVU is calculated and is multiplied by the RVU's assigned to the intermediate product to determine its cost. DSS assumes that the cost of producing an intermediate product is exactly proportional to the RVU's assigned to it. The Department Cost Manager (DCM) is the name of the DSS program that distributes overhead costs and determines the cost of each intermediate product.

RVU's play an important part in the cost allocation system. The same standard set of RVU's is provided to each facility when DSS is implemented. That starting set of RVU weights was developed in specific studies at different VA facilities that were thought by DSS managers to be the best available information. Facilities are encouraged to modify RVU's to reflect local factors. It is important that the RVU's accurately reflect the relative amount of resources used to produce each intermediate product. That same concern applies to the traditional method of cost-adjusted charges. The use of RVU's is an advantage of the DSS system, for unlike charges, those are explicitly chosen to represent the relative cost of producing different patient care products. Another advantage of DSS is the use of six sets of RVU's, one for each of six types of cost.

The Clinical Cost Manager (CCM) is the program that aggregates data by patient encounter. It characterizes the number of intermediate products used, their cost, and the total cost of that encounter. An inpatient encounter is a hospital stay. An

outpatient encounter is defined as a clinic visit, with a residual category for all other services provided on a single day (eg, lab tests conducted and prescriptions filled).

Evaluation of DSS Design

This section compares the design of DSS to the criteria to evaluate whether a cost system can be used for cost-effectiveness analysis: whether it is detailed, comprehensive, and can be aggregated.

DSS provides much of the fine level of detail needed for many cost analyses. It can identify the cost of different intermediate products, distinguish fixed from variable cost, and identify hospital costs exclusive of physician services. DSS does not, however, determine the cost of all possible intermediate products because of the system's reliance on the pre-existing VISTA utilization data. Other providers have long had an incentive to document the services they provide; if they did not provide an itemized bill, they were not reimbursed. As VA has not routinely prepared bills, it has not been required to document all utilization. An important area of omission is inpatient medical procedures. For example, cardiac catheterizations are not recorded in the utilization data of most medical centers. When that occurs, DSS cannot estimate a unit cost, and the cost of the cardiac catheterization laboratory is assigned to all medical inpatient stays in proportion to their length, regardless of whether the patient was catheterized.

DSS is fairly comprehensive, providing cost estimates of all health care received by VA patients, regardless of setting. One exception is the care provided by contract providers operating outside VA facilities. The cost of most contract care is excluded from DSS, although there are plans to include it in the future. DSS also allows the tabulation of costs incurred at all facilities in a region. However, data from different regions are isolated and, therefore, the only way to determine all costs incurred by a patient in all regions is to tabulate 22 different regional data bases. Authority to access DSS data is decentralized. A researcher who seeks to undertake such a tabulation would need to obtain permission from the directors of some 150 VA facilities.

The greatest limitation to DSS stems from its the inability to study data from more than a single region at a time. The developers of the DSS system anticipated the need to make comparisons between facilities. DSS "activity summaries" tabulate groups of encounters. A standard summary prepared by all facilities, termed the corporate roll up, tabulates data from each facility on all stays for a given DRG. It is not now possible, however, to tabulate data across regions on other subgroups of patients; for example, it is not possible to find the mean cost of acute stays in a given DRG exclusive of long-term care stays. There is currently no way to use the system to find the national average cost of intermediate products, the average cost of health care encounters by any characteristic other than DRG, or the average annual cost of a group of patients defined in any other way. An extract of DSS could circumvent this limitation, as is discussed later.

Methods to Assess DSS Validity

Our validity study included a comparison of DSS data to VA utilization databases. We compared DSS hospital data from 3 sites to the VA discharge data base, the Patient Treatment File (PTF). We extracted data from both DSS and PTF on all stays of less than 181 days that ended in September, 1996. Those data included DSS records without cost estimates and stays that began before DSS implementation. Two independent methods were used to extract DSS data; they yielded identical results. We matched stays in the DSS to the PTF using social security number, admission date, and discharge date.

We also compared the number of visits recorded in DSS outpatient data to the VA ambulatory care data base, the Outpatient Care file (OPC). We extracted DSS and OPC data on visits at six different facilities in September, 1996; at this time, DSS defined an outpatient encounter as all care provided in a single day. We excluded missed visits and visits which involved only pharmacy, as those appear in DSS but not the OPC. We used two methods of extracting DSS data at one site, and those yielded the same result.

We then examined a summary of DSS data on hospital stays at 35 VA medical centers. That corporate roll up data base included aggregate information on patients discharged from those facilities during the last 8 months of the 1995 to 1996 fiscal year (February–September, 1996). That data, the only comprehensive source of DSS data from facilities in multiple regions of the US, does not include any patient level detail. Instead, it provides the number of

discharges, the average cost and the average length of all stays in the same DRG at the same facility, including long-term care stays.

We tabulated the number of hospital stays and the days of hospitalizations reported in the PTF at those 35 facilities using the same criteria to create the corporate roll up, counting hospital stays that ended during the same 8-month period, and excluding stays that began before DSS was implemented at the site.

We compared the DSS cost estimates in the roll up to relative value units reported by the Health Care Financing Administration (HCFA) for Medicare patients. We estimated a multivariate regression, using average cost as the dependent variable. The independent variables were the resident to bed ratio, the Medicare wage index,[5] the Medicare DRG weight,[6] and the deviation from the expected length of stay (that is, the deviations from the mean length of stay for VA patients in that DRG according to the DSS data). Variables were transformed by expressing them as a deviation from the mean so the intercept is the average cost when all variables are at their mean. The wage rate and index of teaching activity were included to avoid omitted variables bias.

We also used DSS to find relative value weights using HCFA's method, but with some modifications. HCFA uses hospital charges, we used the DSS cost estimate. We were unable to trim outlier observations or to exclude long-term care stays, as the DSS data did not include information on individual stays. Like HCFA, we standardized charges by dividing them by the wage index and again by a the facility-specific Indirect Medical Education adjustment, a factor that depends on the ratio of residents to beds.[7] We found the medical education factor for each facility from a count of residents obtained from the VA Office of Academic Affairs and used the average daily census from the VA discharge file with the assumption of 60% occupancy as the count of hospital beds. The average standard cost of each DRG was divided by the mean standard cost all stays. We multiplied the resulting weights by 1.46058, the factor used by Medicare in 1997 to adjust weights for the secular increase in patient acuity.

Results of Validity Study

The results of our comparison of DSS and PTF inpatient data are presented in Table 1. Most stays appeared in both data sets. Stays that appeared in both data sets had the identical DRG. Of the stays reported in the DSS, 3.7% were not found in the PTF. Of the stays reported in the PTF, 7.6% were not reported in the DSS. Although those three facilities were in different DSS implementation rounds, the percentage disagreement did not correlate with how recently DSS had been implemented at the site. Those differences occurred even though DSS and PTF are based on the same source, VISTA. Further research is needed to ascertain the reason for those differences.

The results of our comparison of DSS and the OPC are presented in Table 2. Utilization in the DSS did not match the OPC exactly. There are fewer outpatient encounters in the DSS than in the OPC. The DSS reported between 68.8% and 97.1% of the encounters, depending on the facility. We identified visits with no costs assigned to them by DSS at facility A. Those additional records accounted for all visits present in the OPC which did not appear in the original DSS extract at that facility. We did not have permission to use DSS and to make that same comparison at the other five facilities.

Our comparison of the DSS corporate roll up to the PTF data found that DSS included 100.4% as many stays as were reported in the PTF. At the facility level, DSS accounted for as little as 84.1% to as much as 144.6% of the number of hospitalizations in the PTF. At the median facility, the DSS roll up reported 98.4% of the hospital stays reported in the PTF. The correspondence was fairly high, with DSS data at 29 of 35 facilities falling within the range of 95% to 101% of the number of stays reported in the PTF.

There was less correspondence between days of stay. DSS reported 105.8% as many days as the PTF. At the facility level, DSS accounted as little as 33.8% to as much as 280.5% of the number of days in the PTF, with a median of 90.3%. DSS data fell within the range of 95% to 101% of the number of days reported in the PTF at only 7 of 35 facilities. The greater discrepancy between DSS and PTF regarding days of stay may be caused by inexact information on the precise date of DSS implementation at each facility; we may not have excluded the same long-term stays excluded from the DSS roll up.

We analyzed the corporate roll up to see if the relationship between diagnosis and cost was similar to the relationship between diagnosis and charges for Medicare patients. Although Medicare

TABLE 1. VA Hospital Stays Comparison of Number of Stays Reported in Decision Support System (DSS) and Patient Treatment File (PTF) September, 1996

Facility	Stays Recorded in Both DSS and PTF	Stays Recorded in DSS Only	Stays Recorded in DSS Only as % of DSS	Stays Recorded in PTF Only	Stays Recorded in PTF Only as % of PTF
A	711	47	6.20%	73	9.31%
B	276	4	1.43%	12	4.17%
C	493	6	1.20%	36	6.81%
Total	1,480	57	3.71%	121	7.56%

charge data do not represent a gold standard to evaluate measures of resource use, they are the only readily accessible and nationally representative data on hospital costs.

The corporate roll up included 9,589 records, each representing all patients in a given DRG discharged from a single medical center. We excluded 82 records from our analysis because they used a DRG that has been discontinued by HCFA or because the DRG was reported as "other." We excluded one record which reported the average length of stay to be a negative number; that left 9,506 records for analysis. The mean values of those records are presented in Table 3.

The results of a multivariate regression using average cost per discharge as the dependent variable are presented in Table 4. All parameters were statistically significant. That regression explained 50.1% of the variance in average costs. Each additional DRG weight added $5,723 in cost. Each additional day beyond the mean length of stay expected for that DRG added $91.95 in cost.

The VA-specific DRG weights determined from the roll-up data had, by construction, a discharge weighted mean value of 1.46 (the mean value of Medicare DRG weights). The unweighted mean was 1.70, median 1.12, and a standard deviation of 1.96. Values ranged from .07 to 23.01. The HCFA weights for those same 420 DRG's had a mean of 1.42, a median of .966, and a standard deviation of 1.63. Values ranged from 0.31 to 16.57.

The VA DRG weights were more dispersed than the HCFA weights. This is not surprising, as they are based on a smaller sample size and more heterogenous care, including long-term and psychiatric care. In addition, outliers were trimmed from the HCFA calculation, but not from the DSS data.

The simple correlation coefficient between the two sets of weights was 0.853. When mental health DRG's were excluded, the simple correlation between the two sets of weights was 0.858. The correlation between DRG weights suggests that the relative quantity of resources used by veterans hospitalized in the VA, as measured by DSS, correlates fairly highly with the resources used by Medicare patients in the same DRG, as measured by billed charges. There are a number of reasons for which the correlation is not perfect. VA may have different practice patterns. The VA data included long-term care patients. VA treats many more nonelderly patients than are included in the Medicare data. As the available DSS data is not patient level, and as it does not distinguish long-term care, the relative importance of those different factors cannot be identified.

Those findings from the DSS roll up are undoubtedly influenced by the inclusion of long-term care stays. The inability to exclude long-term care data makes it difficult to compare DSS cost estimates from the roll up with other studies of VA cost.

TABLE 2. VA Outpatient Encounters Comparison of Number of Stays Reported in Decision Support System (DSS) and Out Patient Care File (OPC) September 1996

Facility	DSS Count of Encounters	OPC Count of Encounters	Percent in DSS
A	25,372	26,129	97.1%
D	4,415	4,826	91.5%
E	5,979	6,419	93.1%
F	8,736	12,689	68.8%
G	28,455	29,786	95.5%
H	7,453	9,527	78.2%
Total	80,410	89,376	90.0%

TABLE 3. VA Hospital Stays (FY96) DSS Corporate Roll Up and Related Data Variables and Descriptive Statistics

	Mean	Range	SD
Medical Centers (n = 35)			
HCFA wage index	0.99	0.74–1.41	0.17
Residents	63.0	0.0–184.0	55.2
Beds	333	49–1,174	245
Days of stay	57,344	7,588–266,001	54,316
Discharges	3,855	938–13,867	2,573
Diagnostic related groups (DRG) (n = 420)			
HCFA DRG weight	1.42	0.31–16.57	1.63
VA DRG weight (see text)	1.70	0.07–23.01	1.96
Hospital stays in same DRG at a medical center (n = 9,506)			
Number of hospitalizations	14.2	1–637	33.6
Average cost	8,259	146–206,285	10,710
Average length of stay (LOS)	12.1	1.0–2,053.6	35.5

Discussion

The DSS system has great promise to be used for cost-effectiveness research in VA. That promise will be realized only if the data are valid and are easier to access. The validity of DSS hinges on the accuracy of utilization data. The lack of information on inpatient medical procedures represents a serious weakness. Most facilities do not record those procedures and the resources required to provide them are not captured by DSS. As a result, DSS may not be useful when inpatient procedures are a substantial part of the cost which are being studied. VA needs to enter procedures into VISTA so that DSS may assign their cost to the stays in which they are incurred.

It is hard to distinguish long-term from acute hospital care in DSS. Some facilities record stays involving both types of care as a single hospital stay, with a transfer between units within the facility. DSS provides tools to distinguish long-term from acute care, but they are not easy to apply. VA needs to record this acute care as distinct stays, so that it can compare its costs with the non-VA sector. Improvements are also needed to determine costs of long-term care patients who have not yet been discharged.

TABLE 4. Multivariate Cost Regression VA Hospital Stays (FY96) DSS Corporate Roll Up (n = 9,506)

	Parameter	T-Statistic
Intercept	8,259.20	106.46
HCFA DRG weight	5,722.75	87.50
LOS-mean los for DRG	91.95	39.49
Wage index	1,510.00	3.35
Resident/Bed ratio	6,791.71	11.02
R-squared	0.5012	

Incomplete recording of utilization threatens the validity of DSS. If utilization is not completely represented in the DSS, then cost is being spread over too few units of utilization, and DSS cost estimates are too high. In 1997, VA implemented procedures to audit DSS. Those procedures reconcile DSS data against utilization and financial databases. Although VA has established performance standards for DSS, those standards are based only on the timeliness of completing DSS data processing. VA needs to include data validity as a performance standard.

An important limitation to the research use of the DSS system is the difficulty in accessing data. Although all DSS data reside on a main frame computer in Austin, TX, the data are recorded in many different data bases, and the authority to access them is decentralized. Permission to use data must come from either the facility director or from the regional network. VA needs to develop a policy that allows researchers to apply to a centralized authority to obtain access to data from multiple facilities.

The only available tabulation of DSS data across different regions of the US is the information in the roll up file, which is limited to tabulations of stays by DRG. VA needs to create an encounter-specific summary to overcome that limitation. An inpatient file, with one record per discharge, and an outpatient file, with one record per visit, will be of great value for health services research and clinical trials. Those extracts will allow the costs of patients to be tracked across multiple facilities and will permit the tabulation of the costs incurred by groups of patients defined by characteristics other the DRG, including both inpatient and outpatient costs. They will also allow managers and planners to make comparisons of cost and productivity among facilities in different networks.

VA has made a tremendous investment in DSS. Local staff are undertaking the very difficult and time-consuming task of determining the cost and productivity of each department at some 150 sites. Such an effort is beyond the capability of any single research project. With more valid data, improved access, and an encounter level extract, VA will be able to realize the full potential of the DSS system, to conduct better cost-effectiveness research, and to become a more cost-effectiveness health care provider.

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