Hospital Management

(available by anonymous ftp or on WWW with URL

ftp://orion.uwaterloo.ca/pub/henry/teaching /w97/370.w97/latexfiles/hospit.ps.gz)

(SIAM Review, June, 1995)

Suppose that the manager of a hospital in the U.S. wishes to increase charges a fixed percentage over the charges of the past year. One approach would be to assign an across-the-board increase to each department. However, this strategy might not result in the most favourable increase in revenue for the hospital. The reason for this is that most hospitals do not receive a direct return on their charges, particularly if a large share of their patients are supported by Medicare or Medicaid.

Hospital services are divided into several departments, each of which administers a number of procedures. The hospital sets a specific charge for each procedure, and the return for these charges depends on whether or not a patient is a Medicare/Medicaid beneficiary. If a patient is not a Medicare/Medicaid beneficiary, we may assume that the hospital receives all of the charges for that patient. (Although in reality there is a certain percentage of bad debt, we ignore these at this time.)

Reimbursements for Medicare/Medicaid patients are divided into two groups depending on whether the service is inpatient or outpatient. If the charge is to a Medicare/Medicaid inpatient, the hospital receives a fixed amount that does not depend upon charges. Since this source of revenue is constant with respect to changes in the hospital's charges, it will be ignored in our discussion.

If the charge is to a Medicare/Medicaid patient for outpatient service, the hospital is usually reimbursed through a cost accounting procedure. First, a fixed Medicare/Medicaid cost for each department is determined following government guidelines. Then the hospital's Medicare/Medicaid outpatient reimbursement for each department is this fixed cost multiplied by the percentage of Medicare/Medicaid outpatient charges for that particular department.

GAMS Program

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$TITLE  HOSPITAL MANAGEMENT
$OFFUPPER
* This problem finds a maximum increase in revenue given
*   a fixed percentage increase in charges.
*
*  References:
*              SIAM Review, June, 1995
*

  SETS
       D   hospital departments   / D1*D5 /
       P   procedures           / P1*P5/ ;


TABLE    C(D,P) amount of total charges dept d procedure p
                  P1          P2         P3         P4        P5
        D1       5.4740     1.1761    16.9716    16.9824   23.3673
        D2      13.2425    22.7580     1.8171    22.6163   11.6111
        D3      16.7787    19.0550    15.7909    12.6131   23.5245
        D4      0.1925     6.5613    22.1177    12.9073    1.2521
        D5      9.5854     1.1866     6.8177     7.9758   19.0379   ;

TABLE    M(D,P) amount of Medicaire.Medicaide outpatient charges
                  P1          P2         P3         P4        P5
        D1      1.6711    18.4020    10.9103    24.6661   19.2551
        D2      10.4371     8.2059    19.1624    12.3494   20.6954
        D3      17.1693    15.8160    11.9433     6.6536    3.1341
        D4      14.7244    18.9103     5.9444     2.2683    0.3967
        D5      23.2609    24.7759     6.8727    23.6941   17.2114   ;
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TABLE    O(D,P) other non M.M  charges dept d procedure p
                        P1          P2         P3         P4        P5
              D1       21.1542    9.1335     8.9816     1.8437    21.7062
              D2       13.1732    6.1760     4.1627    12.5177    15.7386
              D3       2.2991    24.5638    12.1629     9.6036    18.4056
              D4       16.3480   18.0665    22.4414     6.9270    18.1353
              D5       10.4000   18.8339    22.7302    22.8454    24.9864 ;

PARAMETER Co(D)  fixed M.M cost for dept d
           / D1   5.8299
             D2    7.6580
             D3    8.7754
             D4    12.8318
             D5    14.7778   /;


 SCALAR q overall charge increase qx100 percent   /0.10/ ;


 VARIABLES
   r(D,P)  fraction increase in charge of proc p in dept d
   Z       total return in revenue  ;

  r.LO(D,P) = -0.05;
  r.UP(D,P) =  0.15;
```

```
EQUATIONS
     CHARGE      charge increase
     COST        define objective function;

CHARGE ..       SUM((D,P),  C(D,P)*r(D,P))
                   -  q*SUM((D,P),  C(D,P)  ) =E= 0;

COST ..         Z  =E=  SUM(D, SUM(P, O(D,P)*(1+r(D,P)) )+
             Co(D)*
            SUM(P, M(D,P)*(1+r(D,P)) )  /
            SUM(P, C(D,P)*(1+r(D,P)) )
                                                                    )

MODEL HOSPITAL /ALL/ ;

SOLVE HOSPITAL USING NLP MAXIMIZING Z ;

DISPLAY R.L, R.M ;
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- VAR R  fraction of increase in charge of proc p in dept d

         LOWER     LEVEL     UPPER    MARGINAL

D1.P1    -0.050     0.150     0.150    18.100
D1.P2    -0.050     0.150     0.150    10.013
D1.P3    -0.050     0.051     0.150      .
D1.P4    -0.050    -0.050     0.150    -5.973
D1.P5    -0.050     0.150     0.150     9.700
D2.P1    -0.050     0.150     0.150     6.459
D2.P2    -0.050    -0.050     0.150    -6.314
D2.P3    -0.050     0.150     0.150     4.976
D2.P4    -0.050     0.150     0.150     0.516
D2.P5    -0.050     0.150     0.150    10.981
D3.P1    -0.050    -0.050     0.150    -5.203
D3.P2    -0.050     0.150     0.150    15.712
D3.P3    -0.050     0.150     0.150     4.723
D3.P4    -0.050     0.150     0.150     3.401

---- VAR Z               -INF    478.387     +INF        .
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----    78 VARIABLE  R.L
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	P1	P2	P3	P4	P5
D1	0.150	0.150	0.051	-0.050	0.150
D2	0.150	-0.050	0.150	0.150	0.150
D3	-0.050	0.150	0.150	0.150	0.150
D4	0.150	0.150	0.150	-0.050	0.150
D5	0.150	0.150	0.150	0.150	0.150

```
----    78 VARIABLE  R.M
```

	P1	P2	P3	P4	P5
D1	18.100	10.013		-5.973	9.700
D2	6.459	-6.314	4.976	0.516	10.981
D3	-5.203	15.712	4.723	3.401	6.004
D4	20.229	18.220	7.146	-2.327	17.286
D5	6.527	24.663	17.189	20.873	8.942

```
**** OBJECTIVE VALUE          478.3866
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```
----    80 VARIABLE  R.L

          P1         P2         P3         P4         P5
D1      0.150      0.150      0.047     -0.050      0.150
D2      0.150     -0.050      0.150      0.150      0.150
D3     -0.050      0.150      0.150      0.150      0.150
D4      0.150      0.150      0.150     -0.050      0.150
D5      0.150      0.200      0.150      0.150      0.150

----    80 VARIABLE  R.M

          P1         P2         P3         P4         P5
D1     18.100     10.015                -5.972      9.701
D2      6.461     -6.312      4.976      0.518     10.982
D3     -5.202     15.714      4.724      3.402      6.005
D4     20.229     18.221      7.148     -2.326     17.286
D5      6.467     24.648     17.149     20.821      8.833

**** OBJECTIVE VALUE          478.3866
**** OBJECTIVE VALUE          479.6194
  r.UP("D5","P2")=0.20;
shadow price   -   24.663
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----    80 VARIABLE  R.L
        P1        P2        P3        P4        P5
D1     0.150     0.150    -0.016    -0.050     0.150
D2     0.150    -0.050     0.150     0.200     0.150
D3    -0.050     0.150     0.150     0.150     0.150
D4     0.150     0.150     0.150    -0.050     0.150
D5     0.150     0.150     0.150     0.150     0.150

----    80 VARIABLE  R.M
        P1        P2        P3        P4        P5
D1    18.097    10.038              -5.954     9.706
D2     6.492    -6.243     4.955     0.580    10.994
D3    -5.178    15.741     4.747     3.420     6.039
D4    20.229    18.230     7.180    -2.308    17.288
D5     6.541    24.665    17.199    20.885     8.971

**** OBJECTIVE VALUE          478.3866
  UP was 0.15

**** OBJECTIVE VALUE          479.6194
r.UP("D5","P2")=0.20;
shadow price   -   24.663

**** OBJECTIVE VALUE          478.4140
r.UP("D2","P4")=0.20;
shadow price   -    0.518
```