PROJECT- 7

HEALTHCARE COST ANALYSIS

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Project 7-Healthcare Cost Analysis

#DESCRIPTION

Background and Objective:

- A nationwide survey of hospital costs conducted by the US Agency for Healthcare consists of hospital records of inpatient samples. The given data is restricted to the city of Wisconsin and relates to patients in the age group 0-17 years. The agency wants to analyze the data to research on healthcare costs and their utilization.

Domain: Healthcare

Dataset Description:

Here is a detailed description of the given dataset:

Attribute	Description
Age	- Age of the patient discharged
Female	- A binary variable that indicates if the patient is female
Los	-Length of stay in days
Race	-Race of the patient (specified numerically)
Totchg	-Hospital discharge costs
Aprdrg	-All Patient Refined Diagnosis Related Groups

Analysis to be done:

Question 1. To record the patient statistics, the agency wants to find the age category of people who frequently visits the hospital and has the maximum expenditure.

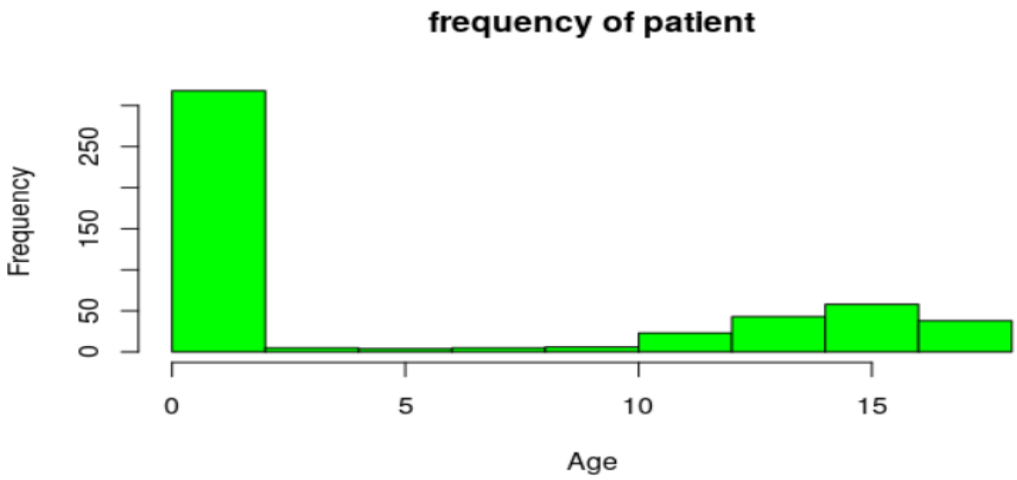
Solution 1:

To find the category that has the highest frequency of hospital visit, we can use graphical analysis. A histogram would display the number of occurrences of each age category. The as.factor() is called to make sure that the categories are not treated as numbers.

Code :

```
library(openxlsx)

hospitalcosts_R<-read_xlsx (file.choose()) # to read xlsx file

View(hospitalcosts_R)   # to view file

head(hospitalcosts_R)  # to see first part of the data usually 6 rows of the data

hist (hospitalcosts_R$AGE, main = "frequency of patient", col="green, xlab ="Age") # to see insight details
```

Output :



Conclusion:

From the graph that is displayed, we can see that infants have the maximum frequency of hospital visit, going above 300

Code: summary(as.factor(hospitalcosts_R$AGE)) # to see the category of infants

Output :

```
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17
307  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38
```

Conclusion:

The summary of AGE attribute gives the numerical output (after converting the age from numeric to factor) – and we can see that there are 307 entries for those in the range of 0-1 year.

Now to calculate maximum expenditure –

Aggregate function is used to add the expenditure from each age and then max function used to find highest costs.

Code:

```
aggregate(TOTCHG~AGE,FUN=sum,data = hospitalcosts_R)
```

Output:

```
   AGE  TOTCHG
1    0  678118
2    1   37744
3    2    7298
4    3   30550
5    4   15992
6    5   18507
7    6   17928
8    7   10087
9    8    4741
10   9   21147
11  10   24469
12  11   14250
13  12   54912
14  13   31135
15  14   64643
16  15  111747
17  16   69149
18  17  174777
```

Code:

```
max(aggregate(TOTCHG~AGE,FUN=sum,data = hospitalcosts_R))
```

Output:

```
[1] 678118
```

maximum expenditure done

Conclusion :

So again result is age group 0 (infant) for maximum expenditure.

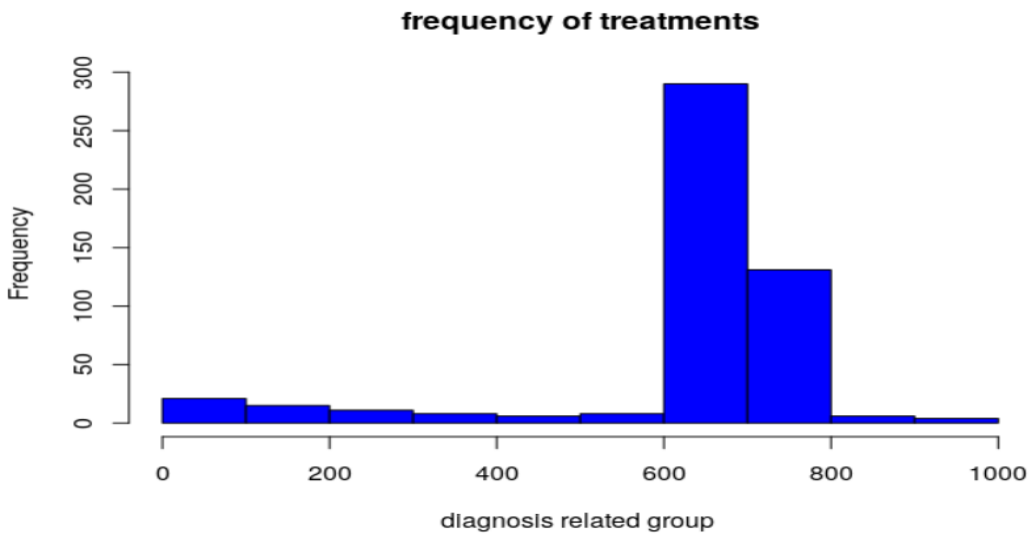
Question 2. In order of severity of the diagnosis and treatments and to find out the expensive treatments, the agency wants to find the diagnosis related group that has maximum hospitalization and expenditure.

Solution 2:

Code:

```
hist(hospitalcosts_R$APRDRG, main = "frequency of treatments", col="blue",
     xlab=" diagnosis related group ")
```

Output:



Now we will make sure that category column("APRDRG") is numerical and then generate a summary along with the which.max to generate the max index of the category data frame, this will be followed by aggregate function used in a similar way as above.

Code:

```
APRDRG_fact<-as.factor(hospitalcosts_R$APRDRG)

summary(APRDRG_fact)
```

Output:

```
21  23  49  50  51  53  54  57  58  92  97 114 115 137 138 139 141 143 204
  1   1   1   1   1  10   1   2   1   1   1   1   2   1   4   5   1   1   1
206 225 249 254 308 313 317 344 347 420 421 422 560 561 566 580 581 602 614
  1   2   6   1   1   1   1   2   3   2   1   3   2   1   1   1   3   1   3
626 633 634 636 639 640 710 720 723 740 750 751 753 754 755 756 758 760 776
  6   4   2   3   4 267   1   1   2   1   1  14  36  37  13   2  20   2   1
811 812 863 911 930 952
  2   3   1   1   2   1
```

Code:

```
which.max(summary(APRDRG_fact))
```

Output:

```
640
 44       # Element
```

Code:

```
df<-aggregate(TOTCHG~APRDRG,FUN = sum,data=hospitalcosts_R)

df
```

Output :

```
   APRDRG TOTCHG
1      21  10002
2      23  14174
3      49  20195
4      50   3908
5      51   3023
6      53  82271
7      54    851
8      57  14509
9      58   2117
10     92  12024
11     97   9530
12    114  10562
13    115  25832
14    137  15129
15    138  13622
16    139  17766
17    141   2860
```

18	143	1393
19	204	8439
20	206	9230
21	225	25649
22	249	16642
23	254	615
24	308	10585
25	313	8159
26	317	17524
27	344	14802
28	347	12597
29	420	6357
30	421	26356
31	422	5177
32	560	4877
33	561	2296
34	566	2129
35	580	2825
36	581	7453
37	602	29188
38	614	27531
39	626	23289
40	633	17591
41	634	9952
42	636	23224
43	639	12612
44	640	437978
45	710	8223
46	720	14243
47	723	5289
48	740	11125
49	750	1753
50	751	21666
51	753	79542
52	754	59150
53	755	11168
54	756	1494
55	758	34953
56	760	8273
57	776	1193
58	811	3838
59	812	9524
60	863	13040
61	911	48388
62	930	26654
63	952	4833

Code:

```
df[which.max(df$TOTCHG),]
```

Output:

```
      APRDRG    TOTCHG
44      640        437979
```

Conclusion:

So conclude that category 640 has the maximum hospitalizations by a huge number (267 out of 500), along with this it also has the highest hospitalization cost.

Question 3. To make sure that there is no malpractice, the agency needs to analyze if the race of the patient is related to the hospitalization costs.

Solution 3:

Here we will first remove the "NA" values from our database, then factorize the Race variable to generate a summary, additionally to verify whether race made an impact on the hospital costs we will use ANOVA function with TOTCHG as dependent variable and RACE as grouping variable.

#H0: The race of the patient is related to the hospitalization costs.

#Ha: no relation.

Code:

```
hosp<-na.omit(hospitalcosts_R)       # to omit NA values from dataset

hospitalcosts_R$RACE<-as.factor(hospitalcosts_R$RACE) # to factorize the Race variable.
```

Apply ANOVA test for two or more than two samples

```
model_aov<-aov(TOTCHG~RACE,data = hospitalcosts_R)

model_aov
```

Output:

```
Call:
   aov(formula = TOTCHG ~ RACE, data = hospitalcosts_R)

Terms:
                      RACE    Residuals
Sum of Squares     18593279   7523518505
Deg. of Freedom       5        493

Residual standard error: 3906.493
Estimated effects may be unbalanced
```

Code:

```
summary(model_aov)
```

Output:

```
              Df      Sum      Sq  Mean   Sq F value  Pr(>F)
RACE           5    1.859e+07   3718656    0.244       0.943
Residuals    493   7.524e+09   15260687
```

Code:

```
summary(RACE)  # to get the summary of  hospital cost per race.
```

Output:

```
   1   2   3  4  5  6
484   6   1  3  3  2
```

Conclusion:

F value is quite low, which means that variation between hospital costs among different races is much smaller than the variation of hospital costs within each race, and P value being quite high shows that there is no relationship between race and hospital costs, thereby accepting the Null hypothesis. Additionally, we have more data for Race 1 in comparison to other races (484 out of 500 patients) which make the observations skewed and thus, all we can say is that there isn't enough data to verify whether race of a patient affects hospital costs.

Question 4. To properly utilize the costs, the agency has to analyze the severity of the hospital costs by age and gender for proper allocation of resources.

Solution 4:

Now to analyze the severity of costs we will use linear regression with TOTCHG(Cost) and independent variable along with AGE and Female as dependent variables.

Code:

```
hospitalcosts_R$FEMALE<-as.factor(hospitalcosts_R$FEMALE

model_lm4<-lm(TOTCHG~AGE+FEMALE,data = hospitalcosts_R)  #calling Regression function

summary(model_lm4)
```

Output:

```
Call:
lm(formula = TOTCHG ~ AGE + FEMALE, data = hospitalcosts_R)

Residuals:
   Min      1Q  Median      3Q     Max
 -3403   -1444    -873    -156   44950

Coefficients:
             Estimate  Std. Error  t value     Pr(>|t|)
(Intercept)  2719.45    261.42      10.403      < 2e-16 ***
AGE           86.04     25.53       3.371      0.000808 ***
FEMALE1     -744.21    354.67      -2.098      0.036382 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3849 on 496 degrees of freedom
Multiple R-squared:  0.02585,          Adjusted R-squared:  0.02192
F-statistic: 6.581 on 2 and 496 DF, p-value: 0.001511
```

Code:

```
summary(hospitalcosts_R$FEMALE)  # for comparing genders
```

Output:

```
  0   1
244 255
```

Conclusion:

Age has more impact than gender according to the P-values and significant levels, also there are equal number of Females and Males and on an average (based on the negative coefficient values females incur lesser hospital costs than males.

Question 5. Since the length of stay is the crucial factor for inpatients, the agency wants to find if the length of stay can be predicted from age, gender, and race.

Solution 5:

Using linear Regression, we can show whether length of stay is dependent on age, gender or race. Here we LOS is the dependent variable and age, gender and race are independent variables.

Code:

```
hospitalcosts_R$RACE<-as.factor(hospitalcosts_R$RACE)

model_lm5<-lm(LOS~AGE+FEMALE+RACE, data= hospitalcosts_R)

summary(model_lm5)
```

Output:

```
Call:
lm(formula = LOS ~ AGE + FEMALE + RACE, data = hospitalcosts_R)

Residuals:
   Min     1Q   Median    3Q    Max
-3.211 -1.211 -0.857    0.143   37.789

Coefficients:
             Estimate   Std. Error   t value  Pr(>|t|)
(Intercept)  2.85687    0.23160      12.335   <2e-16 ***
AGE          -0.03938    0.02258     -1.744   0.0818 .
FEMALE1       0.35391    0.31292      1.131   0.2586
RACE2        -0.37501    1.39568     -0.269   0.7883
RACE3         0.78922    3.38581      0.233   0.8158
RACE4         0.59493    1.95716      0.304   0.7613
RACE5        -0.85687    1.96273     -0.437   0.6626
RACE6        -0.71879    2.39295     -0.300   0.7640
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.376 on 491 degrees of freedom
Multiple R-squared:  0.008699,  Adjusted R-squared:  -0.005433
F-statistic: 0.6156 on 7 and 491 DF, p-value: 0.7432
```

Conclusion:

p-values for all independent variables are quite high thus signifying that there is no linear relationship between the given variables, finally concluding the fact that we can’t predict length of stay of a patient based on age, gender and race.

Question 6. To perform a complete analysis, the agency wants to find the variable that mainly affects the hospital costs.

Solution 6:

Using linear Regression, we can show which variable affects the hospital costs the most, thus TOTCHG becomes dependent variable and rest all variables are taken as independent.

Code:

```
model_lm6<-lm(TOTCHG~AGE+FEMALE+RACE+LOS+APRDRG,data=hospitalcosts_R)

summary(model_lm6)
```

Output:

```
Call:
lm(formula = TOTCHG ~ AGE + FEMALE + RACE + LOS + APRDRG,
    data = hospitalcosts_R)

Residuals:
   Min     1Q    Median     3Q    Max
 -6367   -691   -186        121   43412

Coefficients:
              Estimate    Std. Error   t value  Pr(>|t|)
(Intercept)    5024.9610     440.1366   11.417   < 2e-16 ***
AGE            133.2207       17.6662    7.541   2.29e-13 ***
FEMALE1       -392.5778      249.2981   -1.575    0.116
RACE2          458.2427     1085.2320    0.422    0.673
RACE3          330.5184     2629.5121    0.126    0.900
RACE4         -499.3818     1520.9293   -0.328    0.743
RACE5        -1784.5776     1532.0048   -1.165    0.245
RACE6         -594.2921     1859.1271   -0.320    0.749
LOS            742.9637       35.0464   21.199   < 2e-16 ***
APRDRG          -7.8175        0.6881  -11.361   < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2622 on 489 degrees of freedom
Multiple R-squared:  0.5544,    Adjusted R-squared:  0.5462
F-statistic:  67.6 on 9 and 489 DF, p-value: < 2.2e-16
```

Conclusion:

Age and length of stay affect the total hospital costs. Additionally, there is positive relationship between length of stay to the cost, so with an increase of 1 day there is an addition of a value of 742 to the cost.