National Inpatient Sample: Big Data Issues

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The amount of money spent on health care runs into trillions of dollars seemingly out of control. A question arose how much money Americans spend on being treated in hospitals.

1. **Exordium**

Nationwide Inpatient Sample (NIS)

The Healthcare Cost and Utilization Project (HCUP) is funded by the Agency for Healthcare Research and Quality (AHRQ). Federal and State Governments along with Industry provide money to AHRQ. The Nationwide Inpatient Sample (NIS) is one of the major databases compiled and maintained by the HCUP.

<u>What is NIS?</u>

It is the largest all-payer inpatient care database in the United States. NIS data are available from 1988 to 2011 (24 years). If one wants to examine trend over time, one needs at least 20 years data. This data base is adequate to examine the trend of any phenomenon of interest over time with reference to hospital admissions.

<u>**Big Data**</u>

This is an example of Big Data.

What is Big Data?

In Statistics departments, traditionally, they deal with ‘small n – small p’ data. (n is the number of observations and p is the number of variables.) A new discipline emerged, namely Bioinformatics, to handle ‘small n – large p’ data. (Genome Wide Association Data, Gene Expression Data, Protein Expression Data, Metabolomics, etc.) ‘Large n’ data come under the purview of Big Data or Data Science.

In 2013, ~ 3000 exabytes of data existed on the internet. Of the data that exists in the world now, 90% was created in the last two years. The growth is exponential with an estimated growth rate of 10%. (Source: Dr. Eric Rozier, Head of the Trustworthy Systems Engineering Laboratory, Coral Gables, FL.)

Basic Unit of Data: a Byte

KB (Kilobyte) 10^3 bytes

MB (Megabyte) 10^6 bytes

GB (Gigabyte) 10^9 bytes

TB (Terabyte) 10^{12} bytes

PB (Petabyte) 10^{15} bytes

EB (Exabyte) 10^{18} bytes

ZB (Zettabyte) 10^{21} bytes

YB (Yottabyte) 10^{24} bytes

XB (Xenottabyte) 10^{27} bytes

SB (Shiletnobyte) 10^{30} bytes

DB (Domegemegrottebyte) 10^{33} bytes

How do we handle vast data sets?

We need a fusion of Statistics, Computer Science, and Mathematics. NSF and NIH created special divisions to encourage proposals on big data.

A word of exhortation from Bin Yu, Berkeley, ex-president of the Institute of Mathematical Statistics:

Statisticians are data scientists, but so are other people from Computer Science, Electrical Engineering, Applied Mathematics, Physics, Biology, and Astronomy. In my view, the key factor of gain success in data science is human resource: we need to improve our interpersonal, leadership, and coding skills. There is no doubt that our expertise is needed for all big data projects, but if we do not rise to the big data occasion to take leadership in the big data projects, we will likely become secondary to other data scientists with better leadership and computing skills. We either compute or concede.

What is going on in our neighborhood?

1. University of Northern Kentucky is now offering a Bachelor's degree program in Data Science.
2. Ohio State University has created a new department of data science offering graduate degree programs in data science.
3. Computer Science Department and Business School at UC are offering a 20-credit certificate program in Big Data.
4. Division of Epidemiology and Biostatistics at UC is contemplating a Ph.D. program with Big Data track.
5. I am offering a 3-credit class on 'Introduction to Data Science' next Spring semester.

<u>Back to NIS data …</u>

<u>**Population and Sampling Scheme**</u>

<u>Year 2008</u>

The basic sampling unit for this project is a hospital admission and discharge, called 'episode,' in every year of interest. Consequently, information about the episodes should come from our hospitals. The population of interest is the collection of all episodes. Episodes that occurred in VA hospitals were excluded. Episodes that occurred in hospitals in the Indian Reservations were excluded.

Some states did not participate in the study. Of course those states' hospitals were excluded. We modify the definition of our population. The population of interest is all episodes in all hospitals excluding those mentioned. The size of the population is about 95% of all episodes that occurred in all the hospitals.

The goal is to draw a 20% random sample of episodes. With an estimated number of episodes to be about 40,000,000, the task of drawing a sample is daunting. A simple random sample is not practical. For a simple random sample, one needs to number the episodes serially and then set about drawing a random sample of about 8,000,000 episodes. Implementation is impossible. HCUP followed a stratified cluster random sampling method. From the view point of getting a representative sample and better inference, stratified random sampling beats simple random sampling heads and shoulder. A stratified random sampling scheme can be devised in many different ways. The basic idea is to divide the entire population into strata in an illuminating way, and then draw a random sample from each stratum.

HCUP sampling procedure

There were 4,310 hospitals in the United States excluding VA hospitals, Indian Healthcare hospitals, and those hospitals that belong to states which did not participate. Stratification was done on hospitals. A 20% sample of hospitals amounted to 862 hospitals. Stratification was done with respect to 4 categorical variables on the hospitals.

A. Geographic region
1. *Northeast*
2. *Midwest*
3. *West*
4. *South*
B. Control
0. Government or Private
1. Government, nonfederal
2. Private, not-for-profit
3. Private, investor-owned

4. Private, either not-for-profit or investor-owned

C. Location/Teaching
1. Rural
2. Urban nonteaching
3. Urban teaching

D. Bedsize
   1. Small
   2. Medium
   3. Large

Identify all hospitals that fit the description of one level of each categorical variable. For example, the symbol 1311 indicates all those hospitals located in the *Northeast, private (investor-owned), rural and with a small number of beds.* This is one stratum.

Total number of strata: 4*5*3*3 = 180. In some strata, there were no hospitals or very few hospitals. Some of these strata were merged. The final tally of strata was 60. In other words, all hospitals were segregated into 60 strata.

From each stratum of hospitals, a 20% random sample of hospitals was chosen. For this they have used systematic sampling. How does this work? Suppose a stratum has 100 hospitals listed in some order. We want a sample of 20 hospitals. Choose a number at random from 1 to 5. Suppose we get 4. Choose the 4^{th} hospital in the list, then 9^{th}, 14^{th}, etc.

All the episodes in the chosen hospitals constitute HCUP sample. Each of the hospitals in the sample collected data on each inpatient admission.

Information sought is divided into four groups.

1. Core information
   a. Date of admission
   b. Date of discharge
   c. LOS (length of stay)

   d. Reason for admission (coded-APSDRG)
   e. Co-morbidities (coded-APSDRG)
   f. Insurance details
   g. Cost of stay
   h. Zip code of his hospital
   i. ICD-9 code
   j. Etc.
2. Groups
3. Severity
4. Hospitals

I have looked at 2008 NIS data.

The data come in 4 Ascii files.

Ascii File Name	# episodes Or records	# variables	File size	Primary focus of data
2008_NIS_Core	8,158,381	135	2.77 GB	Patient
2008_NIS_DX_PR_GRPS	8,158,381	47	490 MB	Disease
2008_NIS_Severity	8,158,381	40	850 MB	Severity
2008_NIS_Hospitals	1,056	33	205 KB	Hospitals

The data are not free. One can buy any particular year's data.

Cost:

Student: $ 50

Non-student: $ 250

When you buy the data, you get the data in two CDs and an information booklet.

One can buy all years data.

Cost:

Student: $ 250

Non-student: $ 3000

DRG code

This is one of the variables in the data set. For every patient admitted, the hospital determines for what medical condition the patient is treated most predominantly, codified from 001 to 999. DRG = 103 means Headache without complications. DRG code classifies the medical conditions into 999 categories. This coding is specific to our hospitals. Internationally, ICD-9 code (~ 17,000 medical conditions) is used to codify medical conditions.

ICD-10 codes (~ 180,000 medical conditions)

An illustration

A Master's student, Xin Wang, is interested on blood disorders for her thesis.

DRG codes: 811 = Blood Disorders without complications

812 = Blood Disorders with complications

Year of interest: 2009

Total Number of Episodes: 7,810,762

Number of episodes with DRG = 811 or 812: 62,853

Extract this particular subset from the entire 2009 data.

```
> RBCD2009<-read.csv("J:/NISDATARBCD/RBCD2009.csv")

> dim(RBCD2009)

[1] 62853   187

> RBCD2010<-read.csv("J:/NISDATARBCD/RBCD2010.csv")
```

> dim(RBCD2010)

[1] 67964   186

> RBCD2011<-read.csv("J:/NISDATARBCD/RBCD2011.csv")

> dim(RBCD2011)

[1] 69264   186

Summary

<u>Total</u>	<u>Disorders</u>	<u>Percent</u>
7,810,762	62,853	0.80
7,800,441	67,964	0.87
8,023,590	69,264	0.86

What are the variables in the data set?

187 variables

Documentation is available at the HCUP website.

> RBCD2009[1,]

```
  HOSPID AGE AGEDAY AMONTH ASOURCE ASOURCEUB92 ASOURCE_X ATYPE AWEEKEND DIED   DISCWT DISPUB04
1   4005  75     NA      3      NA                           2        0    0 5.346624        1
  DISPUNIFORM DQTR DQTR_X DRG DRG24 DRGVER DRG_NoPOA DSHOSPID  DX1  DX2   DX3  DX4   DX5  DX6
1           1    1      1 812   395     26       812  MED0204 2800 5789 25000 2111 53011 4580
    DX7   DX8   DX9  DX10 DX11 DX12 DX13 DX14 DX15 DX16 DX17 DX18 DX19 DX20 DX21 DX22 DX23 DX24
1 V5861 V4501 V5866 V5863
  DX25 DXCCS1 DXCCS2 DXCCS3 DXCCS4 DXCCS5 DXCCS6 DXCCS7 DXCCS8 DXCCS9 DXCCS10 DXCCS11 DXCCS12
1          59    153     49     47    138    117    257    105    257     257      NA      NA
  DXCCS13 DXCCS14 DXCCS15 DXCCS16 DXCCS17 DXCCS18 DXCCS19 DXCCS20 DXCCS21 DXCCS22 DXCCS23
1      NA      NA      NA      NA      NA      NA      NA      NA      NA      NA      NA
  DXCCS24 DXCCS25 ECODE1 ECODE2 ECODE3 ECODE4 ELECTIVE E_CCS1 E_CCS2 E_CCS3 E_CCS4 FEMALE
1      NA      NA  E9342  E8490  E8798  E8497        0   2617   2621   2616   2621      1
```

```
  HCUP_ED HOSPBRTH HOSPST.x          KEY LOS LOS_X MDC MDC24 MDC_NoPOA MDNUM1_R MDNUM2_R
1       0        0       AZ 4.20091e+12   1     1  16    16        16    17828    17828
  NCHRONIC NDX NECODE NEOMAT NIS_STRATUM.x NPR ORPROC PAY1 PAY1_X PAY2 PAY2_X PL_NCHS2006  PR1
1        4  10      4      0          4412   2      0    1      5   NA                  5 9907
   PR2 PR3 PR4 PR5 PR6 PR7 PR8 PR9 PR10 PR11 PR12 PR13 PR14 PR15 PRCCS1 PRCCS2 PRCCS3 PRCCS4
1 9904                          NA   NA   NA   NA   NA   NA   NA    222    222     NA     NA
  PRCCS5 PRCCS6 PRCCS7 PRCCS8 PRCCS9 PRCCS10 PRCCS11 PRCCS12 PRCCS13 PRCCS14 PRCCS15 PRDAY1
1     NA     NA     NA     NA     NA      NA      NA      NA      NA      NA      NA      1
  PRDAY2 PRDAY3 PRDAY4 PRDAY5 PRDAY6 PRDAY7 PRDAY8 PRDAY9 PRDAY10 PRDAY11 PRDAY12 PRDAY13
1      1     NA     NA     NA     NA     NA     NA     NA      NA      NA      NA      NA
  PRDAY14 PRDAY15 PointOfOriginUB04 PointOfOrigin_X RACE TOTCHG TOTCHG_X TRAN_IN YEAR.x
1      NA      NA                 1               1    1  13597    13597       0   2009
  ZIPINC_QRTL   AHAID HFIPSSTCO H_CONTRL                   HOSPADDR HOSPCITY
1           2 6860225      4007        3 807 South Ponderosa Street   Payson
                      HOSPNAME HOSPST.y HOSPSTCO   HOSPWT HOSPZIP HOSP_BEDSIZE HOSP_CONTROL
1 Payson Regional Medical Center       AZ     4007 4.764706   85541            2            4
  HOSP_LOCATION HOSP_LOCTEACH HOSP_REGION HOSP_TEACH IDNUMBER NIS_STRATUM.y N_DISC_U N_HOSP_U
1             0             1           4          0   860225          4412   129579       81
  S_DISC_U S_HOSP_U TOTAL_DISC YEAR.y HOSP_RNPCT HOSP_RNFTEAPD HOSP_LPNFTEAPD HOSP_NAFTEAPD
1    24215       17       2901   2009         85           4.4            0.8           1.5
  HOSP_OPSURGPCT HOSP_MHSMEMBER HOSP_MHSCLUSTER
1             76              1               4
```

Blood disorder is a broad name. Identify the disease precisely. Get the ICD-9code. The decimal point is missing in the data.

> ICD9<-table(RBCD2009$DX1)

> ICD9

```
 2800  2801  2808  2809  2810  2811  2812  2813  2818  2819  2820  2821  2822  2823  2825  2827
 7674    58   302  8939   166   194    53    42     7   600    65     5    12     7    26    13
 2828  2829  2841  2850  2851  2853  2858  2859  2897  9996 23872 23873 23874 23875 28241 28242
    6     3  2844    39  4856   133   736 11383    47     1   168   107    32  1644    28   538
28249 28260 28261 28262 28263 28264 28268 28269 28311 28521 28522 28529 79001 79009 99989
  110   401   208 13807    27   432    41   540   109  2058  2040  2129    11     1   211
```

> sort(ICD9)

```
 9996 79009  2829  2821  2828  2818  2823 79001  2822  2827  2825 28263 28241 23874  2850 28268
    1     1     3     5     6     7     7    11    12    13    26    27    28    32    39    41
 2813  2897  2812  2801  2820 23873 28311 28249  2853  2810 23872  2811 28261 99989  2808 28260
   42    47    53    58    65   107   109   110   133   166   168   194   208   211   302   401
28264 28242 28269  2819  2858 23875 28522 28521 28529  2841  2851  2800  2809  2859 28262
  432   538   540   600   736  1644  2040  2058  2129  2844  4856  7674  8939 11383 13807
```

Out of 62,853 patients admitted under the broad name of blood disorders, 13,807 of them had ICD-9 code 282.62. This is the most predominant blood disorder.

Top 5 blood disorders

1. 282.62 Hb-SS disease with crisis
2. 285.9 Anemia unspecified
3. 280.9 Iron deficiency anemia unspecified
4. 280.0 Iron deficiency anemia secondary
5. 285.1 Acute posthemorrhagic anemia

The same five ICD-9 codes showed up in the same order as top five for the years 2010 and 2011.

What about gender distribution?

> RBCD2009F<-table(RBCD2009$FEMALE)

> RBCD2009F

```
    0     1
25008 37743
```

> RBCD2010F<-table(RBCD2010$FEMALE)

> RBCD2010F

```
    0     1
27175 40700
```

> RBCD2011F<-table(RBCD2011$FEMALE)

> RBCD2011F

```
    0     1
27106 42078
```

Gender Distribution

Year	Total Cases	Males	Females
2009	62,853	25,008 (40%)	37,743 (60%)
2010	67,964	27,175 (40%)	40,700 (60%)
2011	69,264	27,106 (39.2%)	42,078 (60.8%)

Age distribution

```
> summary(RBCD2009$AGE)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   36.00   60.00   56.25   78.00  109.00      38
> summary(RBCD2010$AGE)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   32.00   58.00   54.58   77.00  106.00      52
> summary(RBCD2011$AGE)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   36.00   61.00   56.69   78.00  109.00      30
```

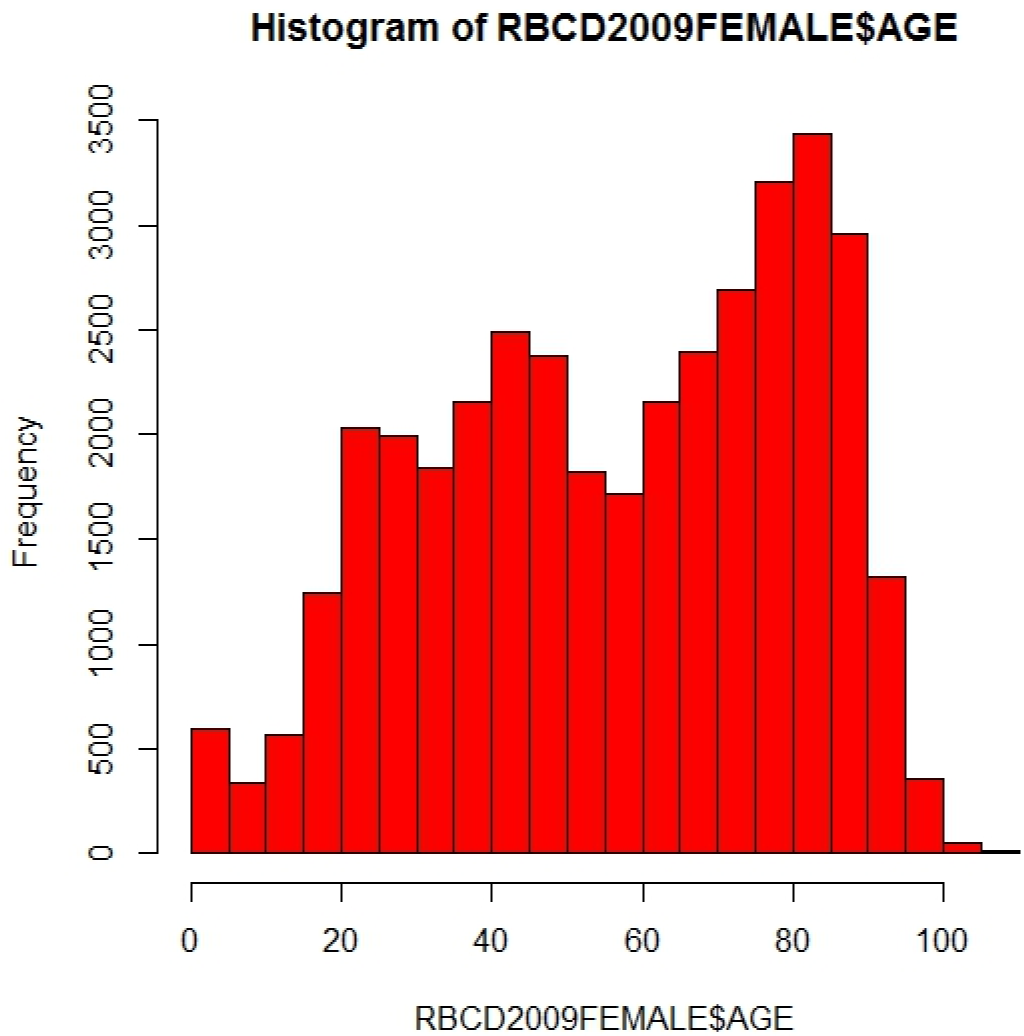
Age distribution gender-wise

```
> RBCD2009FEMALE<-subset(RBCD2009,RBCD2009$FEMALE==1)
```

```
> dim(RBCD2009FEMALE)
[1] 37743   187
> summary(RBCD2009FEMALE$AGE)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   37.00   60.00   56.92   78.00  109.00       5
> RBCD2009MALE<-subset(RBCD2009,RBCD2009$FEMALE==0)
> summary(RBCD2009MALE$AGE)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   32.00   60.00   55.31   77.00  104.00       1
```

Look at the histogram of the age distribution of females for the year 2009.

```
> hist(RBCD2009FEMALE$AGE,col="red")
```



Analysis depends on your imagination and questions you raise …

<u>What did I do with the data?</u>

I started working on the data in collaboration with Dr. Ravi Chinta, Associate Professor, Xavier University. We cannot handle all episodes (over 8 millions) at the same time. Right from the beginning we wanted to focus on one medical condition. We settled for ‘Headache (DRG code = 103)’ and ‘Headache With Complications (DRG code = 102).’ Isolating the episodes pertaining to these conditions netted us over 18,381 episodes for the year 2008. This is the segment of data we wanted to study. The first thing we did was to convert the Ascii data into SPSS files to SAS files to R files.

What is needed to work on such a project?

1. Dexterity with some computing package.
2. A reasonable grounding in sample survey methodology.

Using data from a stratified random sample, one needs to know how to estimate population parameters and provide confidence intervals. A book by Paul Levy and Stanley Lemeshow (Sampling of Populations, Wiley 1991) is helpful. The booklet by HCUP and the website are helpful in explaining how to build national estimates.

We examined a number of variables and their distributions.

1. Gender
2. Distribution of Gender state by state
3. Distribution of Gender region by region (Northeast; south; Midwest; west)
4. Stratum estimates; national estimates
5. LOS (length of stay)
6. LOS national
7. LOS state by state
8. LOS region by region
9. Average cost per day national
10. Average cost state by state
11. Average cost region by region
12. Who paid?
13. Age national
14. Age state by state
15. Age region by region
16. Headaches versus total nationwide
17. Headaches versus total state by state
18. Headaches versus total region by region
19. Etc.

Goal: Estimate the distribution of Gender suffering from headache nationally

Step 1:

Estimate the distribution of Gender stratum by stratum.

Stratum	Male	Female	Total	Male%	Female%	Weight
1011	3	13	16	18.8%	81.3%	6.54
1012	11	19	30	36.7%	63.3%	6.10

Etc.

Note: The weights are proportional to the size (Total Number of Episodes) of the strata. These weights are provided by HCUP. When we want to get a national estimate of the distribution of Gender, we need to calculate the weighted average of strata distributions.

National estimate

Gender:	Male	Female
Percentage:	25.6%	74.4%

Goal: How the distribution of the gender varies from state to state?

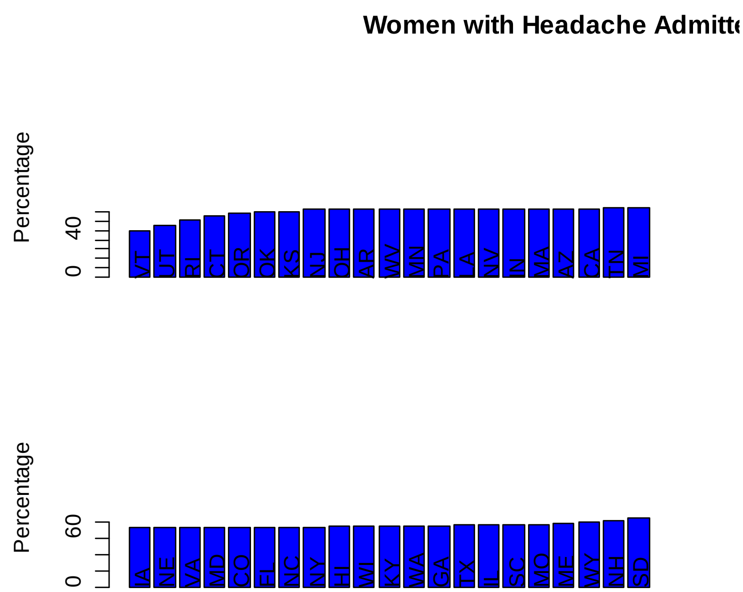
Each hospital is identified by the state in which it is located. Pull out all the episodes that occurred in all hospitals in the state of interest.

State	Male	Female	Total	Male%	Female%
AR	67	177	244	27.5%	72.5%
AZ	130	360	490	26.5%	73.5%

Etc.

A technical note: Recording the data state by state is also stratification. This is post-stratification. One can use the post-stratified data to get a national estimate of the distribution of gender suffering from headaches. This is not a problem. The daunting task is to obtain standard errors. The methodology comes under 'Domain Analysis.'

Here is the bar plot of percentage of women with headache admitted to hospital state by state and sorted from the lowest to the highest.



There is some variation in the percentage of women with headache admitted to hospital, with the least percentage from Vermont at 50% and highest in South Dakota at 85.7%.

Let us look at regional variations.

Region	Male	Female	Total	Male%	Female%
Northeast	1071	2932	4003	26.8%	73.2%
Midwest	997	2828	3925	25.4%	74.6%
South	1909	5696	7605	25.1%	74.9%
West	739	2011	2750	26.9%	73.1%

Total 4716 13567 1828325.8% 74.2%

Inter-regional variation is not much.

Goal: Examine the length of stay

1. The length of stay varied from 0 to 62 days. The length is 0 means that the person was discharged on the same day.
2. The mean length of stay is 2.68 days.
3. The mean length of stay for males is 2.50 days.
4. The mean length of stay for females is 2.75 days.

The distribution of the length of stay in the hospital is given below.

	Length	TotalFrequency	MaleFrequency	FemaleFrequency
1	0	738	226	512
2	1	4894	1477	3417
3	2	5274	1365	3909
4	3	3166	729	2437
5	4	1688	382	1308
6	5	1019	213	806
7	6	572	116	456
8	7	330	79	251
9	8	187	39	148
10	9	129	20	109
11	10	84	17	67
12	11	51	12	39
13	12	36	8	28
14	13	28	6	22
15	14	20	9	11

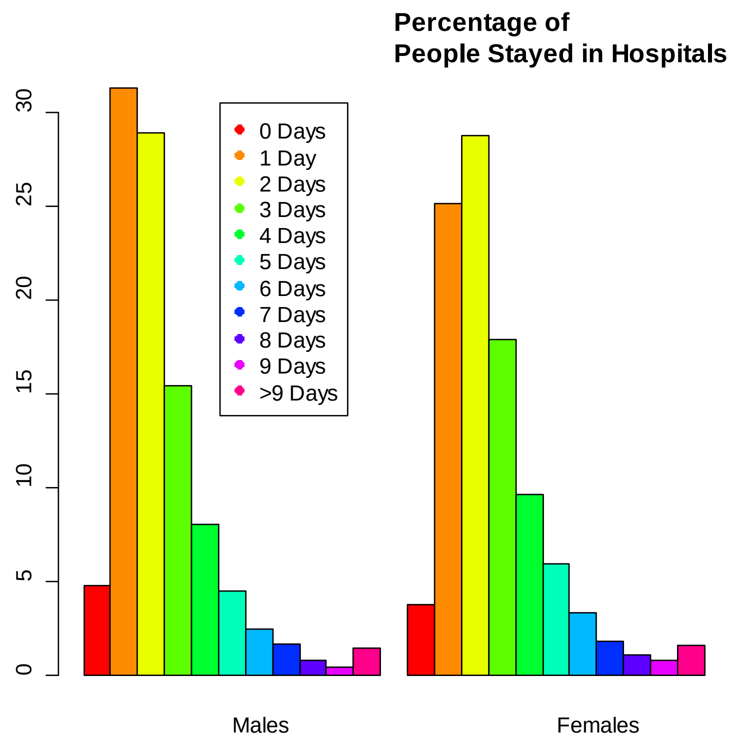
16	15	13	0	13
17	16	8	2	6
18	17	11	3	8
19	18	8	2	6
20	19	4	0	4
21	20	2	1	1
22	22	1	1	0
23	23	4	1	3
24	24	1	1	0
25	26	2	1	1
26	27	1	1	0
27	28	1	1	0
28	29	1	0	1
29	30	2	1	1
30	31	2	1	1
31	35	1	0	1
32	36	1	0	1
33	37	1	0	1
34	40	1	1	0
35	48	1	1	0
36	62	1	0	1

The Distribution of the Length of Stay Gender-wise in Percentages

	Length	MalePer	FemalePer
1	0	4.79	3.77
2	1	31.32	25.19

3	2	28.94	28.81
4	3	15.46	17.96
5	4	8.10	9.64
6	5	4.52	5.94
7	6	2.46	3.36
8	7	1.68	1.85
9	8	0.83	1.09
10	9	0.42	0.80
11	10 or more	1.48	1.59

A bar plot



Goal: How much each patient was charged?

A column in the data with the heading 'TOTCHG' gives total charge levied for each episode. This is what we did with this column.

1. Look at all the episodes in which the patient was discharged on the same day. Take the average of all charges levied.
2. Look at all the episodes in which the patient stayed for one day. Take the average of all charges levied.
3. Look at all the episodes in which the patient stayed for two days. Calculate the charge per day for each patient. Then average.
4. And so on.

The standard deviation of these per day total charges is also calculated. Is it the best way to convey the cost of staying in a hospital when the ailment is headache?

No. of Days Stayed	Total Charge Per Day Mean $	# Episodes
0	9370	729
1	10565	4831
2	6839	5237
3	5477	3139
4	5076	1695
5	4642	1016
6	4559	568
7	4201	322
8	4199	184
9	4045	129
10	4134	84

11	3898	51
12	4027	36
13	3549	28
14	4161	19
15	4172	13
16	4660	8
17	3544	12
18	3696	8
19	4974	4
20	4362	2
22	1824	1
23	5433	4
24	3634	1
26	2897	2
27	4064	1
28	8092	1
29	1455	1
30	6580	2
31	3062	2
35	3803	1
36	6981	1
37	12018	1

40	14794	1
48	6018	1
62	951	1
Total	**7111**	**17407**

What factors influence these charges?

One strong predictor is the number of co-morbidities each episode entails.

No. of co-morbidities	# Episodes	Percentage
0	5577	30.3
1	5371	29.2
2	3829	20.8
3	2131	11.6
4	947	5.2
5	374	2.0
6	104	0.6
7	35	0.2
8	10	0.1
9	3	0.0
Total	**18381**	**100.0**

Gender distribution (percentages)

Year	Females	Males
2005	54	46
2006	55	45
2007	65	35
2008	74	26
2009	73	27

What's going on?

Challenging problems

1. Trend analysis
2. Incidence of headaches in relation to total number of admissions – stratum by stratum – state by state. What is the trend like?
3. When data collection began in 1988 only 8 states participated in the survey. In 2008, 42 states participated. In 2009, 44 states participated. The size of the target population is not the same over the years.
4. Integrating two or more data sets.

Elaboration of Idea 4

We have HCUP data.

EPA has $PM_{2.5}$ Concentration data.

There are more than 1000 monitors around the country monitoring $PM_{2.5}$ (Particulate Matter 2.5). At each site, how much $PM_{2.5}$ accumulated is measured 4 times a day every day.

Here is the idea.

Is headache environmental?

Look at an episode → Look up the Zip code

→ Identify all monitors within 6 mile radius of the zip code

→Average $PM_{2.5}$ concentrations from all the monitors over

the previous ten days from the date of admission

Case - Headache

Control - No headache

Choose control well-matched with the case.

We have $PM_{2.5}$ average for both case and control.

Explore.

We focused on 'headaches.' What about working on other medical conditions? How to get the data?

Connection to Biomedical Engineering

I work with the Tissue Engineering Group.

Team

Dr. David Butler

Dr. Jason Shearn

Andrew Breidenbach, Ph.D. student

Andrea Lalley, Ph.D. student

Steve Gilday, Ph.D. student

I also work with the Biomechanics group.

Dr. Jason Shearn

Rebecca Nesbit, Ph.D. student

Nate Bates, Ph.D. student

The tissue engineering group is concerned with musculoskeletal injuries. They have information on the total number of patients who had injuries of this type for a year or two. Can we use the HCUP data to fine tune the extent of incidence of these injuries over the years? Cost? Length of Stay? Gender? Etc.

DRG = 477: Biopsies of Musculoskeletal System and Connective Tissue

DRG = 478

DRG = 479

<u>Other data sets</u>

<u>KIDS</u>: Data from pediatric hospitals

<u>SIDS</u>: State-wide Inpatient Discharge data

Emergency data

<u>**Introduction to Data Science: Syllabus**</u>

Division of Biostatistics and Epidemiology

Department of Environmental Health

College of Medicine

University of Cincinnati

<u>Syllabus</u>

<u>Title</u>: Introduction to Data Science

<u>Course</u>: BE 7082

Likely to be offered in Spring, 2015 after Curriculum Committee approval

Introduction

Traditionally, Statistics departments work within the environment of ‘small n – small p’ data, where n stands for the number of observations and p for the number of variables. A new discipline ‘Bioinformatics’ arose with the objective of handling ‘small n – large p’ data. Analyses of gene expression data, protein data, polymorphism data, etc. come under the purview of ‘Bioinformatics.’ The next step is dealing with ‘large n’ data. This is what ‘Big data’ is made of. A fusion of Computer Science, Mathematics, and Statistics is needed to handle big data. A data scientist needs more than the fusion. He should be able to harness the following, in order of importance, to be a successful data scientist.

1. Statistics
2. Mathematics
3. Computer Science
4. Machine Learning
5. Domain Expertise (He/she needs to know the field from which the data comes from.)
6. Communication and Presentation skills
7. Data visualization

The purported class is intended to provide an introduction to big data. The students are trained to harness critical skills to become a successful data scientist. The following is an outline of the contents of the course.

<u>Introduction</u>

1. What is Data Science?
2. Examples

<u>Computing skills</u>

3. Introduction to R (ff and bigmemory packages)
4. Python and R
5. Hadoop and R
6. MapReduce, Pregel
7. Cloudera

<u>Machine Learning Tools from Statistics</u>

8. Cluster Analysis
9. Decision Trees and Random Forests
10. Bagging and Boosting
11. Regression

12. Logistic Regression
13. Pattern recognition
14. Naïve Bayes
15. Bayesian Networks
16. Outlier Detection
17. Exploratory data analysis

Applications

18. Text mining
19. Social network analysis
20. Designing a spam filter
21. Forecasting in time series

Data visualization

22. Interactive graphs
23. Spatial graphs
24. Trend graphs

Evaluation

1.	Homework – 10 homework sheets –	30 points
2.	Project (Presentation is required.)	20 points
3.	Mid-term exam -	25 points
4.	Final exam -	25 points

Grades

A – 90 and above

B – 80 – 89

C – 70 – 79

D – 60 – 69

F – Below 60

Text book

Rachel Schutt and Cathy O'Neil – Doing Data Science – O'Reilly, Cambridge, 2013.

References

Deborah Nolan and Duncan Temple Lang – XML and Web Technologies for Data Sciences with R – Springer, New York, 2014.

Nina Zumel and John Mount – Practical Data Science with R – Manning, Shelter Island, 2014.

Drew Conway and John Myles White – Machine Learning for Hackers – O'Reilly, Cambridge, 2012.

Yanchang Zhao – R and Data Mining – Academic Press, New York, 2013.

Vignesh Prajapati – Big Data Analytics with R and Hadoop – Packt Publishing, Mumbai, 2013.

Brett Lantz – Machine Learning with R – Packt Publishing, Mumbai, 2013.

Hadley Wickam – ggplot2 – Elegant Graphs for Data Analysis – Springer, New York, 2009.