IMMC 2018 (International Round)
Problem: The Best Hospital
IMMC2018023

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Introduction

1. Mortality Rate Model For Hospital Quality

1.1 Problem

Develop a model that uses mortality to measure the quality of a hospital. Mortality is counted as the number of avoidable deaths.

1.2 Preliminary Analysis

The definition of avoidable death can reference to the definition provided by Office for National Statistics. According to the Revised Definition of Avoidable Mortality released in 2016, 'Avoidable mortality, which is based on the concept that premature deaths from certain conditions should be rare, and ideally should not occur in the presence of timely and effective health care, is used as an indicator to measure this contribution.'

1.3 Decisive Factors of Avoidable Death

The factors that may affect 'timely and effective health care' are primary diagnosis, age, gender, urgency of admission, comorbidity, length of stay, social deprivation. Our model will be built upon these variables. According to the substantial data which can be measured by setting standards, and therefore the case can be defined as inevitable or avoidable death based on how many it scores. A higher score means that the death is more evitable. To define a death case to be inevitable or avoidable can be done by the table below. Apart from the given factors, we have added three more factors which contribute to the accomplishment of the solution. The three extra factors are 'race', 'socioeconomic class' and 'education level'. According to reference[12], we have used 2 different cases to calculate the inevitable line, if the score beyond the inevitable line, it means that the patient's death is more evitable. The high avoidability case is 14.35 while the low one is 9.3. Therefore, the inevitable line is 11.825.

Firstly, 'primary diagnosis' is considered the most essential factor so we assume the value to be 1. According to appendice[7], if the disease is included in the table, the value will be 1. Secondly, based on the information from reference[7], more than half of the patients who died in the hospital were aged 65 and over while only 6% were under 45 years old. That's why we assume the value of 'under 45' to be 4 and the value of '65 and over' to be 1. Thirdly, according to reference[10], the reference shows that the life expectancy of a transgender person is much shorter than that of man while women live a little longer than men. So the value of 'other' is 0.1, 'male' is 1 and 'female' is 2. Fourthly, for urgency of admission, the value of 'emergency' is 1, 'elective' is 2, and 'not assigned' is 3 as 'emergency' means means the patient's survival rate is relatively low. Fifthly, as comorbidities come with an endless variety, we cannot list all of them so we set the value by how many comorbidities the patient suffer from. Sixthly, on the basis of reference[7], the given chart shows that 45% of the patients who died in the hospital stayed 1-3 days. As a result, the value of '1-3 days' is assumed to be 1 whereas '8-9 days' to be 5 because the

percentage is the lowest. Seventhly, for social deprivation, we define it by the distances from the original location of a patient to a hospital. Eighthly, according to reference[2], it indicates that people of different races have a dissimilar life expectancy. Asian-American people have the longest life expectancy. Hence the value of 'Asian' is 5. Ninthly, in our point of view, 'socioeconomic class' is considered as an important factor and according to reference[9]. Eventually, based on the reference[6], we assume the value of 'less than high school graduate' to be 1.

According to reference[12], we have finally divided the 10 factors into four categories, which are '$\times 1$', '$\times 0.5$', '$\times 0.25$' and '$\times 0.1$'. The higher value represents the factor is more important and have a more remarkable effect on the calculate process. Although this method may not be ideally precise, it is a possible approach for data from only one hospital which cannot be compared across other hospitals.

Primary Diagnosis ($\times 1$)	included in appendice[7]: 1 not included in appendice[7]: 0
Age ($\times 1$)	Under 45 years: 4 45-64 years: 2 65-74 years: 3 75-84 years: 1 85 years and over: 1
Gender ($\times 0.1$)	Male: 1 Female: 2 Other: 0.1
Urgency of Admission ($\times 0.5$)	Emergency: 1 Eletctive: 2 Not assigned: 3
Comorbidity ($\times 0.5$)	One: 5 Two: 4 Three: 3 Four: 2 Five or more: 1
Length of Stay ($\times 0.25$)	1-3 days: 1 4-5 days: 3 6-7 days: 4 8-9 days: 5 10 or more days: 2
Social Deprivation ($\times 0.5$)	less than 100 metres: 4 100-1000 metres: 3 1001-5000 metres: 2 more than 5000 metres: 1
Race ($\times 0.1$)	Black: 2 White: 3 Asian: 5 Native American: 1 Hispanic: 4

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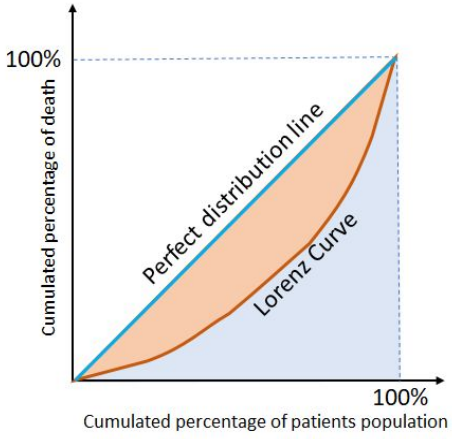
Socioeconomic Class (× 0.25)	Lower class: 1 Working class: 2 Middle class: 3 Upper class: 4
Educational Level (× 0.25)	Less than high school graduate: 1 High school graduate: 2 College graduate: 3 Graduate degree: 4

1.4 Methodology

The scoring system we set to define a death case may not be reliably accurate since most of the data are from researches done in 2010 and 2011 in United State. In order to develop a more precise model, comparison among the data from various hospitals can be an additional approach. In this case, information, including hospital name, patient's state and the above factors about each case is required to classify them. Due to personal privacy, this information should only be available in the hospital internally. Firstly, the listed indicators are to be selected for in order to divide cases on the basis of different hospitals and/or other factors such as disease. Then, the number of patients and the number of death based on the indicators are generated. By calculating the percentage of the number of deaths in relative to the number of patients, the hospitals can be ranked by the ratio of mortality.

So as to calculate the number of avoidable mortality, Gini Index is used to determine the death cases. Gini Index is a statistical measure of distribution which was originally developed as a gauge of economic inequality, measuring wealth distribution, etc. Ironically, we use Gini Index to measuring the equality or inequality of distribution of death cases among the patients population of different hospitals. The model can utilize Gini Index to estimate both the affection of the mortality percentage and the size of the cases. The Gini Index is calculated by the percentage of the area of between the Lorenz curve and the perfect distribution line in relative to the total area of the triangle. The range of Gini Index is from 0 to 1, with index value close to 0 represents that it is equally distributed and index value close to 1 represents that it is in extremely inequality.



In this model, Gini Index serves as a gauge to determine the existence of avoidable deaths. If Gini Index appears to be small (i.e., less than 0.25), it indicates that the mortality rates are relatively equal or the one with more deviated rate weighs less when considering the size of cases. Therefore, it can be considered as most death cases are inevitable and the death rate calculated by the total number of death divided the total number of patients. Hospitals will be ranked by the avoidable mortality rate obtained by calculating the difference between the average inevitable death rate and the hospital's death rate.

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On the flip side, if Gini Index appears to be large (i.e., greater than 0.25), it shows that the mortality rates among different hospitals result in great variations, so avoidable mortalities do exist in certain hospitals. The standard for the existence of avoidable deaths is the Gini Index larger than 0.25.

Acquiring such data, the average inevitable death rate is the death rates averaged over the hospitals except for those with a patient percentage lower than 15%. All patient percentage will be taken into consideration when all hospitals have a patient percentage lower than 15%. The difference between the mortality rate of each hospital and the inevitable death rate will result in the avoidable mortality rate of each hospital and the lower the avoidable mortality rate of a hospital is, the higher its rank will be.

Furthermore, the model will generate a reliability grading from the lowest 1 to the highest 4 depending on its Gini Index.

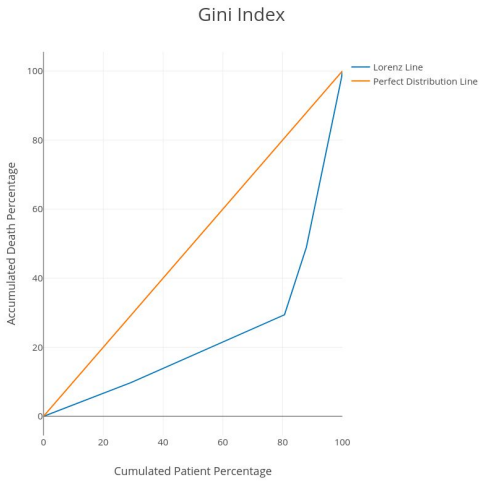
Gini Index	Reliability
0.75 ~ 1.00	4
0.50 ~ 0.75	3
0.25 ~ 0.50	2
0.00 ~ 0.25	1

1.5 Overall Model

Example 1

This is a set of random data for illustrating how the model works. Assuming that the hospitals have already input their data, the first step is to select indicators. Hospital is a must while other factors are optional. In this case, one more factor which is the kind of disease is taken into consideration to calculate the Gini Index. Other factors can also be chosen according to one's preferences. As can be seen above, the model will list the number of patients, the number of death as well as the ratio (number of death/number of patients).

Indicator: Hopital, Diagnosis			
	Number of Patients	Number of Deaths	Ratio
Hospital 1	2	2	100.0%
Hospital 2	80	50	62.5%
Hospital 3	200	10	5.0%
Hospital 4	350	20	5.7%
Hospital 5	50	20	40.0%



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Ordered by Ratio in Ascent					
		Number of Patients	Number of Deaths	Patient Percentage	Death Percentage
1	Hospital 3	200	10	29.33%	9.80%
2	Hospital 4	350	20	51.32%	19.61%
3	Hospital 5	50	20	7.33%	19.61%
4	Hospital 2	80	50	11.73%	49.02%
5	Hospital 1	2	2	0.29%	1.96%
	TOTAL	682	102		

Subsequently, the model will create a new ratio-orientated order to list the hospitals in ascent. The patient ratio (number of patients in one hospital/total number of patients) and the death ratio (number of death in one hospital/total number of death) will be calculated and displayed in percentage.

Cumulated Percentage			
Patient Percentage	Cumulated (Patient)	Death Percentage	Cumulated (Death)
29.33%	29.33%	9.80%	9.80%
51.32%	80.65%	19.61%	29.41%
7.33%	87.98%	19.61%	49.02%
11.73%	99.71%	49.02%	98.04%
0.29%	100.00%	1.96%	100.00%

In order to calculate the Gini Index, it is needed to sum up the percentages. The line graph is then generated. The x-axis is the accumulated percentage of patient population while the y-axis is the accumulated percentage of death. The blue line, which is the Lorenz curve, is created based on the measured data while the orange line is the perfect distribution line. The Gini Index can then be calculated. It is the ratio of the area between the Lorenz curve and the perfect distribution in relative to the area below the perfect distribution line.

To calculate the area, the patient percentage and the accumulated death percentage is extracted. Moreover, the row of 0 is added in the convenience of calculation. Using the patient percentage as height and the accumulated death percentage as topline and baseline to calculate the trapezoids below the Lorenz curve and sum them up to obtain the total area below the curve. The Gini Index is the quotient of the difference between area below the Lorenz curve and the area between the perfect distribution line and the Lorenz curve over the area below the distribution line. From the above data, the Gini Index appears to be 0.5342 which is larger than 0.25 and therefore there are avoidable deaths.

Patient Percentage	Cumulated (Death)	Area
0.0000	0.0000	0.0000
0.2933	0.0980	0.0144
0.5132	0.2941	0.1006
0.0733	0.4902	0.0288
0.1173	0.9804	0.0863
0.0029	1.0000	0.0029
	Total Area	0.2329
	Gini Index	0.5342

$$\text{The Gini Index} = \frac{\textit{Area between the Perfect Distribution Line and the Lorenz Curve}}{\textit{Area below the Perfect Distribution Line}} = \frac{\textit{Area below the Perfect Distribution Line} - \textit{Area bleow the Lorenz Curve}}{\textit{Area below the Perfect Distribution Line}} = \frac{(0.5 - \textit{Area bleow the Lorenz Curve})}{0.5}$$

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Average Inevitable Death Rate					
	Number of Patients	Number of Deaths	Patient Percentage	Ratio	Average Inevitable Death Rate
Hospital 1	2	2	0.29%	~~100.0%~~	Not Taken into Consideration
Hospital 2	80	50	11.73%	~~62.5%~~	Not Taken into Consideration
Hospital 3	200	10	29.33%	5.0%	Taken into Consideration
Hospital 4	350	20	51.32%	5.7%	Taken into Consideration
Hospital 5	50	20	7.33%	~~40.0%~~	Not Taken into Consideration
TOTAL	682	102			5.36%

After taken away the hospital with a patient percentage lower than 15%, the average inevitable death rate is calculated to be 5.36%.

Avoidable Mortality Rate					
Average Inevitable Death Rate		Ratio	Avoidable Mortality Rate	Rank	Reliability
5.36%	Hospital 1	100.00%	94.64%	5	3
	Hospital 2	62.50%	57.14%	4	
	Hospital 3	5.00%	-0.36%	1	
	Hospital 4	5.71%	0.36%	2	
	Hospital 5	40.00%	34.64%	3	

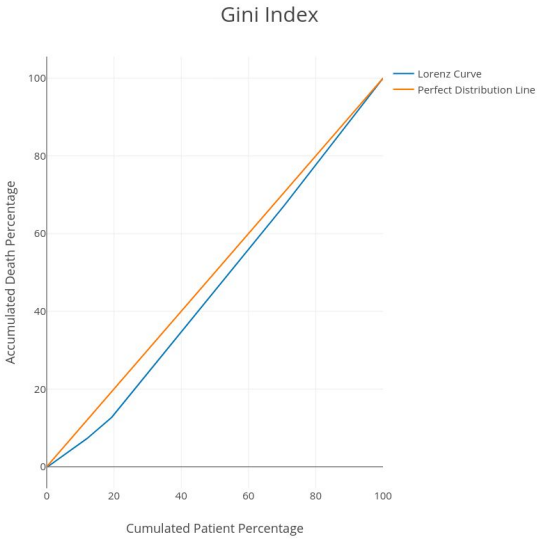
The hospital is then ranked in descending order of avoidable mortality rate. Besides, the reliability of the ranking is shown as 3 due to its Gini Index 0.5342.

Example 2

This is another set of data that also use hospitals and diagnosis as indicators. In this case, based on the prior calculation, the Gini Index is calculated to be 0.0059 and therefore the existence of avoidable death is relatively rare. The average inevitable death rate can then be obtained from those data. The ranking can also be listed, but the reliability of the ranking will be quite low. When such case appears, it is recommended to choose another factor such as age or add additional factors such as classifying using hospitals, diagnosis, and age.

Indicator: Hopital, Diagnosis			
	Number of Patients	Number of Deaths	Ratio
Hospital 1	2	0	0.0%
Hospital 2	80	40	50.0%
Hospital 3	200	180	90.0%
Hospital 4	350	300	85.7%
Hospital 5	50	30	60.0%

Patient Percentage	Cumulated (Death)	Area
0.0000	0.0000	0.0000
0.00	0.00	0.0000
0.12	0.12	0.0069
0.07	0.19	0.0113
0.51	0.70	0.2295
0.29	1.00	0.2494
	Total Area	0.4971
	Gini Index	0.0059



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Average Inevitable Death Rate			
	Number of Patients	Number of Deaths	Average Inevitable Death Rate
Hospital 1	2	0	
Hospital 2	80	40	
Hospital 3	200	180	
Hospital 4	350	300	
Hospital 5	50	30	
TOTAL	682	550	80.65%

Avoidable Mortality Rate					
Average Inevitable Death Rate		Ratio	Avoidable Mortality Rate	Rank	Reliability
80.65%	Hospital 1	0.0%	-80.6%	1	1
	Hospital 2	50.0%	-30.6%	2	
	Hospital 3	90.0%	9.4%	5	
	Hospital 4	85.7%	5.1%	4	
	Hospital 5	60.0%	-20.6%	3	

1.6 Conclusion

The first approach is the scoring system, which allows separative hospitals to measure its avoidable mortality rate in the absence of data from other hospitals. In spite the fact that this scoring system is relatively inaccurate when being used outside the United States, it provides a reference for the hospitals itself.

The second methodology is a rather consummate model since it compares current data from a number of hospitals and uses Gini Index to determine the existence of avoidable mortality. It also provides the reliability of the generated ranking, which can be used as a gauge for researchers in order to adjust the selected indicators.

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2. Overall Model For Hospital Quality

2.1 Problem

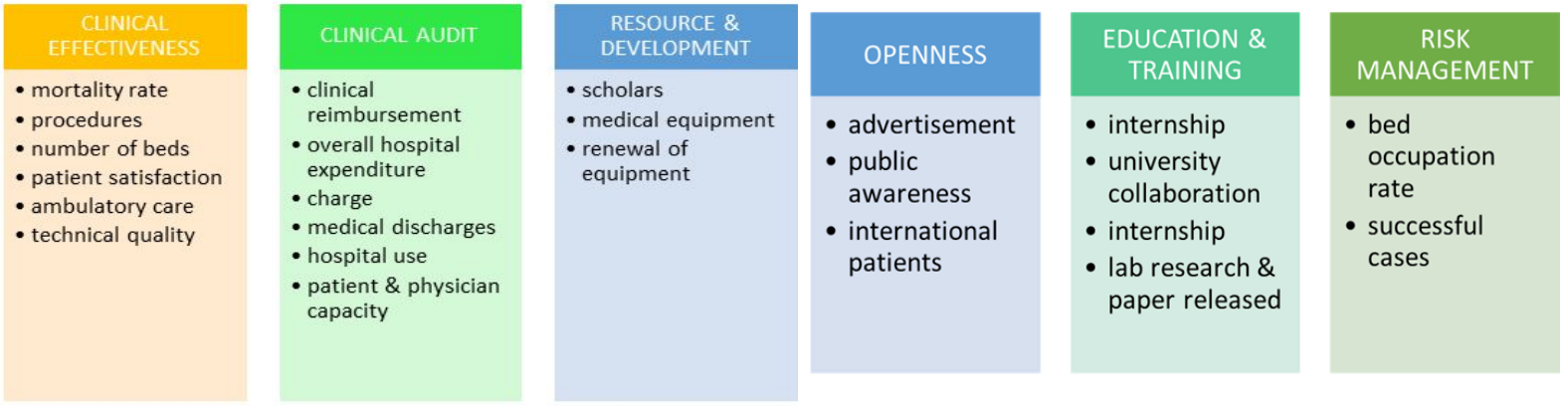
Develop a model that uses other factors, in addition to mortality, to measure the quality of a hospital. Based on the factors you include from particular hospitals, your model must result in information to make a decision of which hospital is the best.

2.2 Preliminary Analysis

According to the problem, data from the world's best 50 hospitals is used for relevance in the solution. The appendice[1] below is just a reference of the quality/ranking of the 50 schools we have chosen. By using the average data in different categories and compare them to the data of the top hospitals, we can create a standard/system to understand the quality of the hospitals in different scopes, and eventually decide which hospital is the best.

2.3 Decisive Factors of the Hospital Quality

The below graph briefly indicates the factors that is possible for deciding the quality of a hospital. As you can see, there are six primary categories including clinical effectiveness, clinical audit, research and development, openness, risk management, education and training. In the following solution, we are going to set criteria for each factors in the different categories.



(Refer to reference[11].)

The Affection of Factor

- Most data are not updated
- Most data are from certain countries
- Subjective data such as patient satisfaction rate do not actually represent the hospital's quality
- Topics are general that they may not represent certain qualities of a hospital
- Data collected may not represent the standard of the quality of a hospital
- Data vary in the internet and therefore may have error or be unaccurrate
- Many data are not provided so that the final grade of the quality of hospitals may be unfair to some of the hospitals

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2.4 Methodology

Prior to the data available online and the top hospitals are mostly from hospital in the United States of America, we are going use the data from the Dartmouth Atlas Project (the Dartmouth Atlas of Healthcare) in our solution.

Grading system 1

Secondly, we are going to compare over the data in different aspects including Quality/Effective Care, End of Life Care, Demographics of the Medicine care Population, Surgical Procedures, Hospital and so on. Using the data of the US national average, 90th percentile, 50th percentile and 10th percentile, we will create a grading system. The grades range from 0 to 10 (0 being the lowest, 10 being the highest).

Calculation

We can start from choosing/calculating the value of grade:10 or grade:0, which is the highest or lowest grade. We can use Excel to find the maximum (or minimum) values. However, if the topic is are negative to the decision of patients, the calculation should be changed to calculating the value of grade:0.

Calculation of Grade:10 and Grade:0

(Details of calculation of grade:10 and/or grade:0 are shown on appendice[2].)

Calculation of evitable mortality rate

Since it is difficult to find the data of evitable and inevitable mortality rate, we ideally assume the death rate associated with ICU admission as unavoidable mortality.

$$\begin{aligned} &\textit{evitable mortality rate}\,(\%) \\ &\quad = \textit{Precent of Deaths Occuring In Hospital}\,(\%) \\ &\quad - \textit{Percent of Deaths Associated With ICU Admission}(\%) \end{aligned}$$

(Details of calculation of evitable mortality rate are shown on the appendice[3].)

After calculating for the value of grade:10 (or grade:0), we can calculate the actual grade of the tested value in a 10-point scale.

POSITIVE DATA:
$\textit{Overall Grade} = \frac{\textit{value of data}}{\textit{value of Grade:10}} \times 10(\textit{in a 10 - point scale})$
NEGATIVE DATA:
$\textit{Overall Grade} = \frac{\textit{value of Grade:0}}{\textit{value of data}} \times 10(\textit{in a 10 - point scale})$

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Example: Category 1 (Clinical effectiveness)

(The values for other categories are shown in the appendice[4].)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Mortality rate	6.86%	9%	7%	5%	2.60%
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.14	0.95	0.75	1.42
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.23	0.86	0.48	1.60
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.13	0.91	0.65	1.45
All Surgical Discharges per 1,000 Medicare Enrollees, by Gender	72.7	78.9	73.9	62.9	82.6
CMS Hospital Compare Summary Quality Scores, by Condition	93.6%	N/A	N/A	N/A	100%
How do Patients Rate the Hospital Overall?, by Response	62.6862 7451% ≈62.69 %	N/A	N/A	N/A	70%
How do Patients Rate the Hospital Overall?, by Response	10.8431 4%≈10. 84%	N/A	N/A	N/A	7%
Total 30-Day Prescription Fills per Beneficiary	48.8	52.3	47.7	42.3	55.9
Percent Filling At Least One Prescription for a Beta-Blocker Following Heart Attack	84.3%	88.7%	85.1%	81.4%	89.7%

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Percent Filling At Least One Prescription for a Proton Pump Inhibitor	25.8%	29.2%	24.6%	20.3%	31.5%
Percent of Medicare Beneficiaries Filling Prescription for a High-Risk Medication	18.4%	23.5%	17.3%	13.2%	11.1%
SNF Days per Decedent, by Interval Before Death	20.6	24.0	18.8	13.5	26.6

(For additional information such as year and region levels, refer to appendice[4].)
(refer to reference[3].)

Overall grade of Category 1 (Clinical effectiveness)

Example (Cleveland Clinic):

Take Cleveland Clinic as an example, the below chart shows the grades before calculating the final grade.

(The values for other categories are shown in the appendice[5].)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Mortality rate	6.86%	2.60%	6.4%	4.0625	7.47608
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.42	1.22	8.591549	
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.60	0.97	6.0625	
Hospital Care Intensity Index, Last Two Years of Life, by Component	1.00	1.45	1.10	7.586207	
All Surgical Discharges per 1,000 Medicare Enrollees, by Gender	72.7	82.6	N/A	N/A	
CMS Hospital Compare Summary Quality Scores, by Condition	93.6%	96.6%	93.8%	9.710144928	

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How do Patients Rate the Hospital Overall?, by Response	62.68627451%≈62.69%	70%	66%	9.428571429	
How do Patients Rate the Hospital Overall?, by Response	10.84314%≈10.84%	7%	12%	5.833333333	
Total 30-Day Prescription Fills per Beneficiary	48.8	55.9	N/A	N/A	
Percent Filling At Least One Prescription for a Beta-Blocker Following Heart Attack	84.3%	89.7%	N/A	N/A	
Percent Filling At Least One Prescription for a Proton Pump Inhibitor	25.8%	31.5%	N/A	N/A	
Percent of Medicare Beneficiaries Filling Prescription for a High-Risk Medication	18.4%	11.1%	N/A	N/A	
SNF Days per Decedent, by Interval Before Death	20.6	26.6	22.7	8.533835	

(For additional information such as year and region levels, refer to appendice[5].)
(refer to reference[3].)

Overall grades

Example (Cleveland Clinic):

The below chart indicates the overall grades calculated in the above process.

Category	Overall grade
Clinical Effectiveness	7.47608
Clinical Audit	9.740579
Resource & Development	8.220887
Openness	N/A
Education & Training	N/A
Risk Management	5.28986

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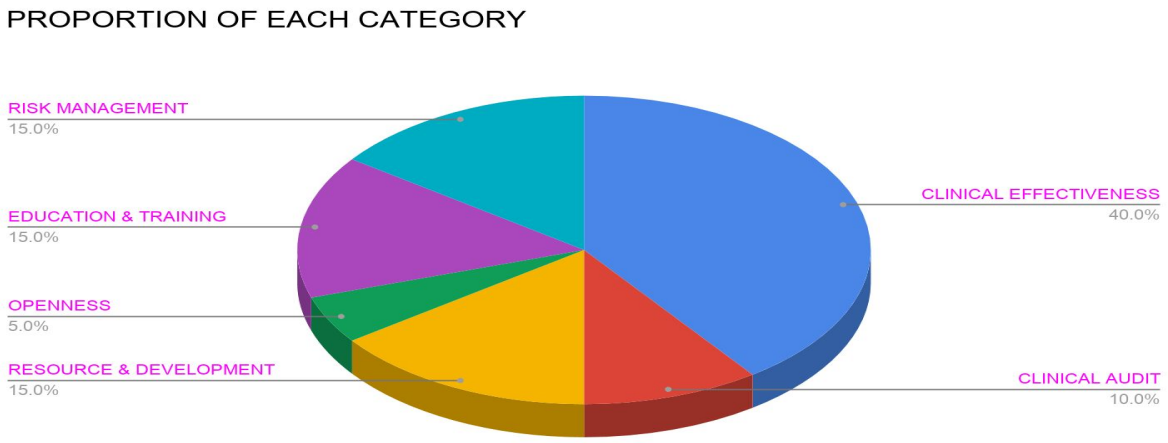
Finally, we need to determine the proportion of each topic to finalize the grade of the hospitals. One of the most influential is the framework put forth by the Institute of Medicine (IOM), which includes the following six aims for the health care system.

THE SIX AIMS
Safe: Avoiding harm to patients from the care that is intended to help them.
Effective: Providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and misuse, respectively).
Patient-centered: Providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions.
Timely: Reducing waits and sometimes harmful delays for both those who receive and those who give care.
Efficient: Avoiding waste, including waste of equipment, supplies, ideas, and energy.
Equitable: Providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status.

(Refer to reference[5].)

According to the above criteria, in addition to our discussion, can be translated into the graph below.



In the above graph, clinical effectiveness significantly occupies almost half of the graph with 40%, while resource & development, education & training and risk management all occupy 15% of the whole chart. Finally, clinical audit and openness holds for 10% and 5% respectively. The reason for the different proportions is due to several factors including:

- **CLINICAL EFFECTIVENESS:** The hospital's actual quality/effectiveness.
- **CLINICAL EFFECTIVENESS:** How people feel about the service in hospital?

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- **REDUCATION & TRAINING:** Are there any education or training programmes for non-patients?
- **RESOURCE & DEVELOPMENT:** Are there any addition resources available to patients and non-patients?
- **RISK MANAGEMENT:** How many authorities working successful medications in the hospital?
- **OPENNESS:** How can overseas patients get admitted to the hospital through different channels such as the internet?
- **CLINICAL AUDIT:** How will the hospital reimburse to patients?

According to the above reasons, we think that clinical effectiveness is really important but not enough to occupy half of the chart since effectiveness differs between different cases. Secondly, additional resources, development and much more are vital to a hospital's on-going expansion, but they will just occupy 15% of the whole chart respectively because they are just secondary or not the most important aspects. Lastly, clinical audit and openness are just superficial information given to patients and therefore the two categories occupy only 10% and 5% differently.

After that, we need to calculate the final grade, which is the grade users can see using grading system 1. Since some of the data could be missing or unprovided by the hospitals, therefore the missing values of overall grades and the number of overall grades calculated will not be calculated in the equation.

$$Final\ Grade = \frac{values\ of\ overall\ Grades \times their\ respective\ proportions(\%)}{the\ total\ of\ proportions}$$

Final grade of Cleveland Clinic

(details of calculation are shown in the appendice[6].)

The final grade of Cleveland is : 7.488877438≈7.45

Errors of Grading system 1

Surprisingly, the final grade of Cleveland Clinic is 7.45. In fact, The grade is quite descent based on some reasons:

- Some data are not provided.
- The areas that Cleveland Clinic is strong in may not be put into calculations.
- The highest or lowest grade (Grade:10 or Grade:0) may be ultimately higher than Cleveland CLinic and/or many other hospitals because the hospital with maximum or minimum grade (Grade:10 or Grade:0) may be extremely powerful in certain areas which Cleveland Clinic do not.
- The proportion of the topics may be unfair to hospitals with few strengths.

Although the grade may seem lower than expected since Cleveland Clinic is claimed the best hospital, undoubtedly, Cleveland Clinic is a very good in a overall or general ground with a 7.45 grade.

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Grading system 2

In this grading system, we will set the percentages of each topic of the hospitals from the data of several hospitals: *Cleveland Clinic (Rank 1)*, *University of Maryland Medical Center (Rank 5)* and *Johns Hopkins Medicine (Rank 3)*, they are considered to be the several best hospitals. After that, we also selected several hospitals and they are: *University of Utah Health Care (Rank 64)*, *University of Wisconsin Health (Rank 45)* and *Lahey Clinic (Rank 69)* which are considered to be some of the ordinary hospitals in the world. *(refer to appendice[1].)*

The reason why we choose the percentages is due to several factors in the hospital. *(Refer to reference[3].)*

1. **Patient experience**

The experience of a patient is highly related to the service quality of a hospital, for example, whether the room is clean or not, pain control or the communication between the doctors and patients can be a factor. In our study, we use two data to represent the patient experience and they are hospital days and physician visits per patient during the last six months of life.

2. **Resource inputs**

Resource inputs, such as the number of intense ICUs and hospital bed distribution, can play an important role in determining the quality of a hospital. In our study, we calculate this rate using two factors: Hospital Bed Inputs during the Last Two Years of Life, and FTE Physician Labor Inputs during the Last Two Years of Life.We added the two total number together so we can compare the data of each hospital easily.

3. **Hospital care intensity**

The Hospital Care Intensity (HCI) index depends on two factors: the length of stay and the number of physicians they meet. It is calculated as the age-sex-race-illness standardized ratio of patient days and visits. For each variable, the ratio of a given hospital's utilization rate to the national average was calculated, and these two ratios were averaged to create the index.

4. **Mortality comparison**

The mortality rate (especially the avoidable mortality rate) reflects the medical level of a hospital significantly. In our project, we choose two sets of data and they are the percentage of death (people aged between 67 to 99) and the percentage of death associated with ICU admission. Using the latter one minus the former one, it will reflect the unavoidable mortality rate in the largest extent. Then we decided to calculate the average of the data of the three best hospitals and the three normal hospitals respectively and compare their values.

5. **Medicare spending**

In our study, we calculate the total number of medicare spending using three data: Total Reimbursements per Patient, Medicare Reimbursements by Site of Care (payment to the different facility/agency and payments to physicians for services), spending by different Type of Service during the Last Two Years of Life.

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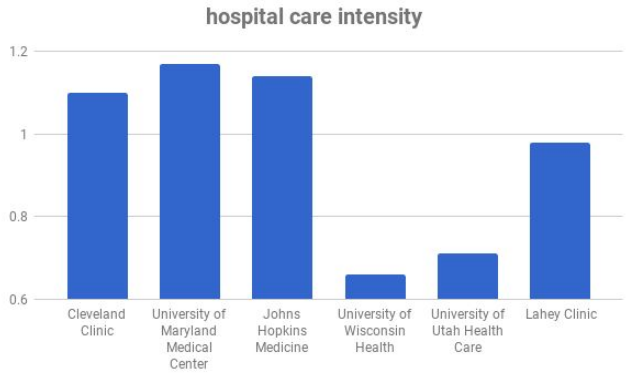
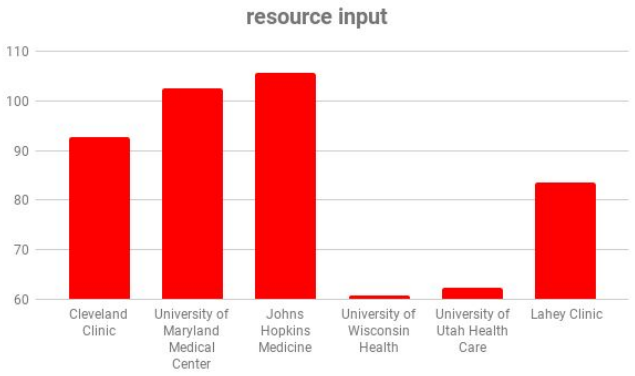
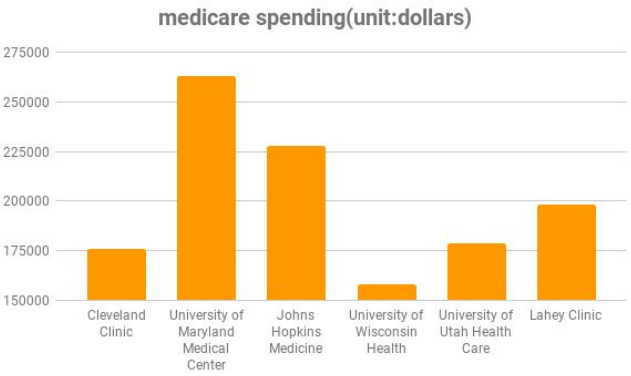
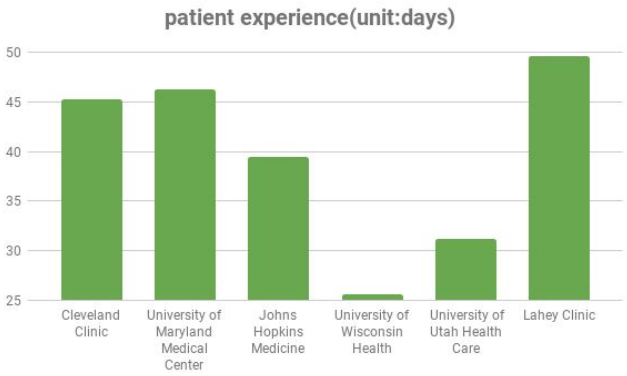
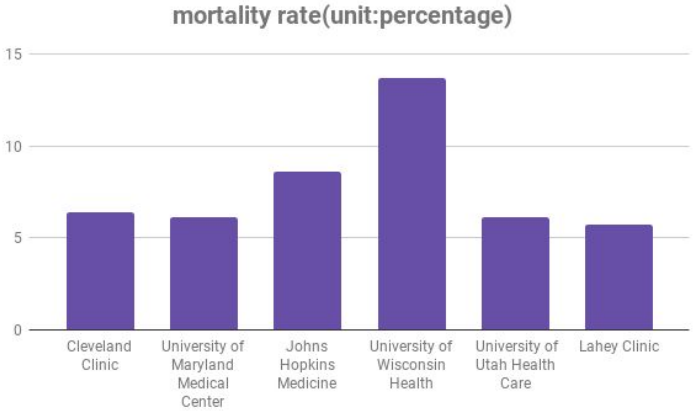
Model

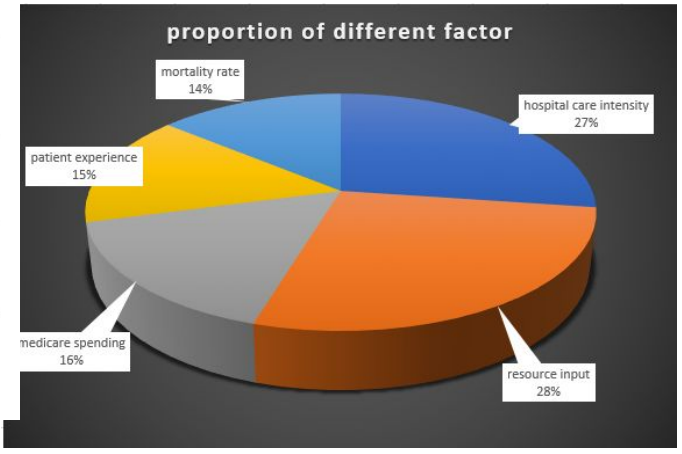












After simple analysis, we discovered that if we only compare the final data of the several hospitals, we cannot deduce which of them play the most important role. Therefore, we calculate the average number of all the best hospitals and the normal hospitals respectively, and using the percentage difference, to determine the ratio of each factor. The percentage difference is known as the difference between two values divided by the average of the two values.

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Comparing the percentage difference of each value, we put the total values of all of them into 100% and calculate the proportion of each of them. The final result is shown in the upper pie chart, and it also shows how important each factor is in estimating the quality of a hospital.

From the result, we can easily to demonstrate that the hospital care intensity and the resource input are the top reasons lead to a good hospital. Therefore, in the' user-friendly memo' part, the two factors will occupy the largest proportion overall.

2.5 Pros & Cons About the Two Grading Systems

	Grading system 1	**Grading system 2**
pros	data contains a lot of aspects, easy to determine a hospital if not consider a certain surgery service.	more accuate data were provided according to the hospital.
cons	too general, data only shows the difference between states.	lack of sample, only six hospital may not reflect the difference clearly. Not many aspects of data were included.

2.6 Conclusion

In order to solve the second question, we set two models/systems to determine the quality of a hospital. The first grading system is similar to hotel grading system, which focuses on the general aspects of hospitals. There are different percentages and equations for the six categories in the calculation. The solution starts by comparing the data and finding the values of grade:10 or grade:0, then we need to calculate the evitable mortality rate, this is because they are no straight-forward data for evitable mortality rate. Secondly, we substitute data including the value of grade:10 or grade:10 and the data of each topic from the hospital of our choice into the calculation for the grade of each topic (in a 10-point scale). Thirdly, we need to calculate the overall grade of each category, which is the average grade of the grades in each topic. After that, we calculate the final grade using the proportion we set for each category, if the values of overall grades are not available (N/A), we ignore them and substitute the ones with values provided into the equation. Finally, we get the final grade of a hospital. The example we use in the calculation is Cleveland Clinic, which is the best hospital according to appendice[1], and the control group we use is from the reference[3]. Finally, the final grade of Cleveland Clinic is 7.45.

The second grading system, which mainly focuses on the difference between independent hospitals, demonstrates more specific results than the grading system 1. The calculation method is simple. In grading system 2, we calculate the percentage difference between the data of the best hospitals and the normal hospitals and deduce the significance of each factor. Therefore, the significance is represented through the final pie chart, and this is the criteria of grading system 2. However, the grading system 2 has its own disadvantages, that is the limited sample. Only six hospitals in total may not enough for estimating the hospital from the whole country.

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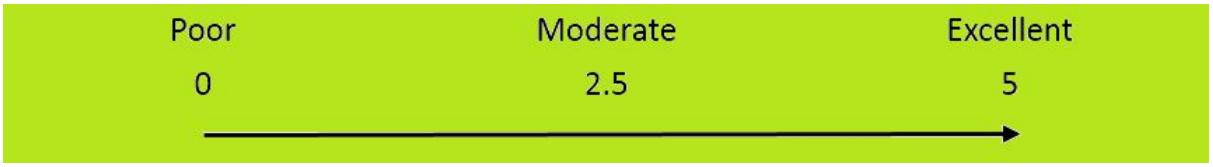
3. User-friendly Memo

How to use?

Please fill the memo.

Give a grade according to your impression about this hospital! The full mark is 5 for each question, and the full mark for the whole paper is 120. Multiply the percentage of each part according to the criteria given by us. The higher the mark is, the better the hospital is. For the criteria part, you can refer to the pie chart in Page 14.



OR YOU CAN...Decide the criteria by yourself!

We noticed that everyone has different opinions when deciding the criteria. Therefore, in this memo, by considering which of the six factors is the most important one, you can create your own criteria and let us know your opinion! (Fill the gap after each subtitle and ensure the sum of them is 100% if you want to set your own criteria)

Clinical effectiveness ***(percentage:_____%)**	Score(0-5)
How do you feel this hospital's actual quality/effectiveness?	
How do you feel about the service in the hospital?	
Are there any authorities working in the hospital?	
How will you rate the working efficiency of the staffs in the hospital?	
Overall Score (Calculate the sum of all the score)	

Education/training ***(percentage:_____%)**	Score(0-5)
Are there any education or training programmes for non-patients?	
How about the doctors you met? Do they all graduate from good university?	
Does it have many internship chances for the doctors?	
Is there any exchange activity for the doctors?	
Overall Score	

Clinical audit ***(percentage:_____%)**	Score(0-5)
How do you feel about the reasonable reimbursement given to patients?	

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How about the physicians and patients capacity?	
Does this hospital have a high discharge rate?	
How about the prices of the service? Does it worth your treatment?	
Overall Score	

Openness *(percentage:_____%)	Score(0-5)
Do you know how can overseas patients get admitted to the hospital through different channels such as the internet?	
How do you know this hospital? Does it enjoy a high public awareness?	
Have you seen any advertisements related to this hospital?	
Is there any international patient?	
Overall Score	

Resource development *(percentage:_____%)	Score(0-5)
Are there any additional resources available to patients and non-patients?	
How about the quality of the medical equipment?	
Does the hospital renew the medical equipment regularly?	
Does the hospital invite the scholars regularly?	
Overall Score	

Risk management *(percentage:_____%)	Score(0-5)
Does it have a low bed occupation rate?	
How about the infection control and the hygiene condition?	
Does the hospital have a high awareness and concern about patients' safety and medical errors?	
Does the hospital require the staff to file incident reports immediately after incidents have taken place(if the incident has happened)?	
Overall Score	

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4. Summary Sheet

Problem 1

In order to rank the hospitals in favor of avoidable mortality rate, the cases are first needed to be defined as inevitable or avoidable. There are two ways to verify a case, scoring system for independent hospitals and overall model for several hospitals. The former one is a set of standards which include different aspects of a death case to define its properties. It contains various attributes such as primary diagnosis, age, gender, urgency of admission, comorbidity, length of stay, and social deprivation, race and socioeconomic class. The properties of each case is then put into the system and a score can be obtained. Each score will then multiply by its effect coefficient. If the sum of the scores is above the inevitable line, the case is then defined as advoidable. The overall model will classify the cases across different hospitals based on the chosen indicators. Gini Index is then calculated in order to determine the existence of avoidable mortality and the reliability of the ranking it generates. Inevitable mortality rate is measured from the Gini Index and avoidable mortality rate can be utilized for ranking the hospitals.

Problem 2

In our study, we create two grading system and they have different pros and cons. The most obvious difference between the two grading system is that grading system 1 uses the data from the whole US, and distinguish better and worse in states. However, this result is too general, and cannot deeply judge the quality of the hospital if considering certain surgery service. In grading system 2, it uses the data from several certain hospitals, and they are more specific compared with the first grading system. Nevertheless, it only uses data from six hospital in total, which means it may not reflect the trend of all hospitals. Also, grading system 1 contains many aspects that include patient participation, but grading system 2 is focus more on the data given by hospitals.

Problem 3

For our ‘user-friendly’ memo, we choose the criteria(proportion) of grading system 1, as it will include more aspects and most of them are related to patient participation. Users need to give a grade on the hospital performance, and they can deduce the quality of a hospital after their marks are calculated under the given standard. Moreover, we decided to give the consumers a chance to develop their own standard, so if we can collect the data from consumers, it will give a possible future insight to the hospitals.

5. References

[1]https://www.kff.org/other/state-indicator/death-rate-by-raceethnicity/
[2] https://bbs.hupu.com/21664191.html

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[3] http://www.dartmouthatlas.org/
[4]https://www.consumerreports.org/hospitals/HowToChooseAHospital/
[5]https://www.ahrq.gov/professionals/quality-patient-safety/talkingquality/create/sixdomains.html
[6]http://www.prb.org/Publications/Reports/2013/us-educational-attainment-mortality.aspx
[7]https://www.cdc.gov/nchs/data/databriefs/db118.pdf
[8]hospital ranking(appendice[1])thttp://hospitals.webometrics.info/en/world
[9]https://pdfs.semanticscholar.org/c929/a6fdc0457b9cc4b329ebda8d7039be511d86.pdf
[10]https://www.quora.com/What-is-the-life-expectancy-of-trans-people
[11]https://www.slideshare.net/MohammedYaserHussain/hospital-quality-management-60681914
[12]https://improvement.nhs.uk/documents/1423/PRISM_2_Manual_V2_Jan_14.pdf

6. Appendices

Appendice[1]

*(Compared between **17261** hospitals from **168** countries in the world, data collected in January,2015)*

ranking	Institution	Country	Size	scholar
1	Cleveland Clinic		230	11
2	St Jude Children's Research Hospital		58	37
3	Johns Hopkins Medicine		23	61
4	Mayo Clinic Scottsdale AZ		125	94
5	University of Maryland Medical Center		92	34
6	M D Anderson Cancer Center		97	39
7	Massachusetts General Hospital		401	18
8	Assistance Publique Hôpitaux de Paris		96	43
9	Memorial Sloan Kettering Cancer Center		26	107
10	New York Presbyterian / Lower Manhattan Hospital		293	218
11	Providence Health & Services		43	127
12	Deer's Head Hospital Center		9	82
13	Buddhist Tzu Chi General Hospital		42	8
14	Beth Israel Deaconess Medical Center Needham		3	30
15	Aurora Health Care		331	7
16	Taipei Veterans General Hospital		315	42
17	Advocate Health Care		268	23
18	University of Pittsburgh Medical Center		85	161

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19	Brigham and Women's Hospital		50	146
20	Hartford Hospital		47	122
21	INCA Instituto Nacional de Câncer		432	26
22	University Clinic Heidelberg Universittsklinikum Heidelberg		108	96
23	Erasmus Medisch Centrum Universitait Medisch Centrum Rotterdam		326	40
24	Asklepios Klinikum Bad Abbach		772	35
25	Xinqiao Hospital Third Military Medical University		234	16
26	Alberta Health Services		502	95
27	Tricare Military Health System		411	152
28	National Taiwan University Hospital		192	240
29	Children's Hospital of Philadelphia		444	155
30	H Lee Moffitt Cancer Center & Research Institute		1790	9
31	Navy Medicine		294	73
32	Children's Mercy Hospitals and Clinics		950	103
33	Jilin University Bethune Hospital - First Hospital of Jilin University		303	57
34	Leiden University Medical Center / Leids Universitair Medisch Centrum		77	90
35	Centre Hospitalier Universitaire Vaudois Lausanne		709	20
36	Arizona State Hospital		857	204
37	Hôpitaux Universitaires de Geneve		798	29
38	Universitätsklinikum Hamburg Eppendorf		159	76
39	Hospital Authority		403	109
40	Universitätsklinikum und Medizinische Fakultät Tübingen		173	58
41	Sahlgrenska University Hospital		1784	3
42	Kaiser Permanente CA		6	2394
43	National Hospital Organization		1412	47
44	University of North Carolina Healthcare		15	131
45	University of Wisconsin Health		590	53
46	Universitätsklinikum Freiburg		823	80
47	Seattle Children's Hospital and Medical Center		619	207
48	University of Chicago Hospitals		982	77
49	Universitätsklinikum Jena Klinikum der Friedrich Schiller		227	55

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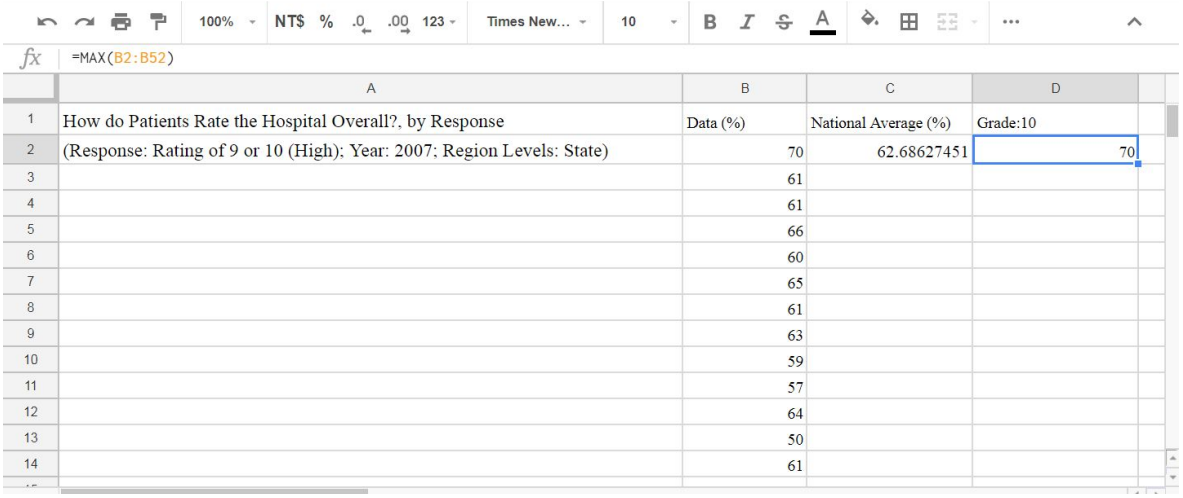
	Universität			
50	Klinik und Poliklinik für Hals Nasen Ohrenheilkunde Ludwig Maximilians Universität München		870	50

Appendice[2]

Calculation of Grade:10 and Grade:0

Method: =MAX(xx:yy) or =MIN(xx:yy)



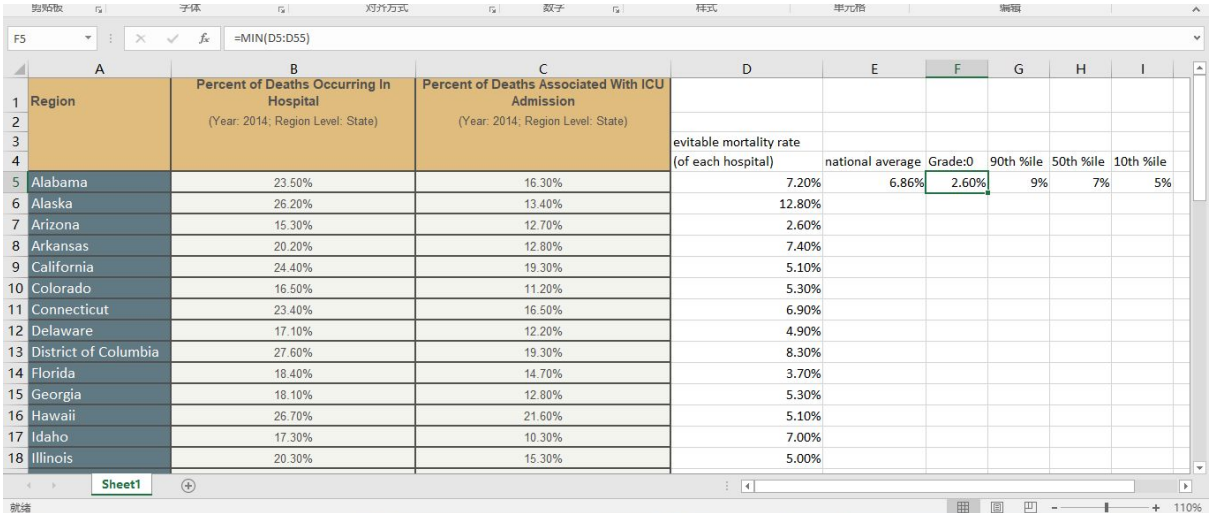
=MAX(B2:B52)

	A	B	C	D
1	How do Patients Rate the Hospital Overall?, by Response	Data (%)	National Average (%)	Grade:10
2	(Response: Rating of 9 or 10 (High); Year: 2007; Region Levels: State)	70	62.68627451	70
3		61		
4		61		
5		66		
6		60		
7		65		
8		61		
9		63		
10		59		
11		57		
12		64		
13		50		
14		61		

Appendice[3]

Calculation of evitable mortality rate:

$$\textit{evitable mortality rate}\,(\%) = \textit{Precent of Deaths Occuring In Hospital}\,(\%) - \textit{Percent of Deaths Associated With ICU Admission}(\%)$$



=MIN(D5:D55)

	A	B	C	D	E	F	G	H	I
1	Region	Percent of Deaths Occurring In Hospital (Year: 2014; Region Level: State)	Percent of Deaths Associated With ICU Admission (Year: 2014; Region Level: State)						
2									
3				evitable mortality rate					
4				(of each hospital)	national average	Grade:0	90th %ile	50th %ile	10th %ile
5	Alabama	23.50%	16.30%	7.20%	6.86%	2.60%	9%	7%	5%
6	Alaska	26.20%	13.40%	12.80%					
7	Arizona	15.30%	12.70%	2.60%					
8	Arkansas	20.20%	12.80%	7.40%					
9	California	24.40%	19.30%	5.10%					
10	Colorado	16.50%	11.20%	5.30%					
11	Connecticut	23.40%	16.50%	6.90%					
12	Delaware	17.10%	12.20%	4.90%					
13	District of Columbia	27.60%	19.30%	8.30%					
14	Florida	18.40%	14.70%	3.70%					
15	Georgia	18.10%	12.80%	5.30%					
16	Hawaii	26.70%	21.60%	5.10%					
17	Idaho	17.30%	10.30%	7.00%					
18	Illinois	20.30%	15.30%	5.00%					

Sheet1

Appendice[4]

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Example: Category 1 (Clinical effectiveness)

(The values for other categories are shown in the appendices.[4])

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Mortality rate	6.86%	9%	7%	5%	2.60%
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Hospital Day Ratio; Year: 2014; Region Levels: State)	1.00	1.14	0.95	0.75	1.42
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Inpatient Visit Ratio; Year: 2014; Region Levels: State)	1.00	1.23	0.86	0.48	1.60
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Overall Index; Year: 2014; Region Levels: State)	1.00	1.13	0.91	0.65	1.45
All Surgical Discharges per 1,000 Medicare Enrollees, by Gender (Gender: Overall; Year: 2014; Region Levels: State)	72.7	78.9	73.9	62.9	82.6
CMS Hospital Compare Summary Quality Scores, by Condition (Condition: Overall; Year: 2007; Region Levels: State)	93.6%	N/A	N/A	N/A	100%

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How do Patients Rate the Hospital Overall?, by Response (Response: Rating of 9 or 10 (High); Year: 2007; Region Levels: State)	62.68627451%≈62.69%	N/A	N/A	N/A	70%
How do Patients Rate the Hospital Overall?, by Response (Response: Rating of 6 or Lower (Low); Year: 2007; Region Levels: State)	10.84314%≈10.84%	N/A	N/A	N/A	7%
Total 30-Day Prescription Fills per Beneficiary (Year: 2010; Region Levels: State)	48.8	52.3	47.7	42.3	55.9
Percent Filling At Least One Prescription for a Beta-Blocker Following Heart Attack (Interval Following Heart Attack: 0-6 Months; Year: 2008-2010; Region Levels: State)	84.3%	88.7%	85.1%	81.4%	89.7%
Percent Filling At Least One Prescription for a Proton Pump Inhibitor (Year: 2010; Region Levels: State)	25.8%	29.2%	24.6%	20.3%	31.5%
Percent of Medicare Beneficiaries Filling Prescription for a High-Risk Medication (Year: 2012; Region Levels: State)	18.4%	23.5%	17.3%	13.2%	11.1%
SNF Days per Decedent, by Interval Before Death (Interval Before Death:	20.6	24.0	18.8	13.5	26.6

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Last Two Years of Life; Year: 2014; Region Levels: State)					

(For additional information such as year and region levels, refer to appendice[4].)

(refer to reference[3])

Category 2 (Clinical Audit)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Total Medicare Reimbursements per Enrollee, by Adjustment Type (Adjustment Type: Price, Age, Sex & Race; Year: 2014; Region Levels: State)	$9,589	$10,320	$9,127	$7,657	$11,221
Total Medicare Reimbursements per Decedent, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)	$69,289	$79,792	$61,882	$55,405	$86,616
Total Part D Spending per Beneficiary (Year: 2010; Region Levels: State)	$2,670	$2,981	$2,526	$2,080	$3,043
Spending on Non-Prescription Services per Part D Beneficiary (Year: 2010; Region Levels: State)	$9,363	$10,491	$8,432	$7,135	$11,415

Category 3 (Resource & Development)

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(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Inpatient Days per Decedent, by Interval Before Death and Level of Care Intensity (Interval Before Death: Last Two Years of Life; Level of Care Intensity: Overall; Year: 2014; Region Levels: State)	14.2	16.2	13.4	10.6	17.8
SNF Bed Inputs per 1,000 Decedents, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)	56.5	65.8	51.5	36.8	73
Hospital Bed Inputs per 1,000 Decedents, by Interval Before Death and Level of Care Intensity (Interval Before Death: Last Two Years of Life; Level of Care Intensity: Overall; Year: 2014; Region Levels: State)	38.9	44.4	36.8	29	55.2
Home Health Agency Visits per Decedent, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year:	25.7	43.7	21.5	9.9	48.9

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2014; Region Levels: State)					

Category 4 (Openness)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Percent of Children in Study Population Insured by Medicaid (Year: 2007-2010; Region Levels: State)	39.5%	N/A	N/A	N/A	N/A

Category 5 (Education & Training)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Percent of Medicare Enrollees Having Annual Ambulatory Visit to a Primary Care Clinician, by Race (Race: Overall; Year: 2014; Region Levels: State)	79.0%	83.7%	79.6%	73.3%	85.3%
Percent of Female Medicare Enrollees Age 67-69 Having At Least One Mammogram Every Two Years, by Race (Race: Overall; Year: 2014; Region Levels: State)	63.11%	69.1%	62.6%	57.1%	74.8%

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Percent of Diabetic Medicare Beneficiaries Age 65-75 Receiving Three Recommended Tests (Year: 2012; Region Levels: State)	53.2%	60.9%	53.1%	46.3%	63.5%
FTE Hospital Employees per 1,000 Residents (Year: 2012; Region Levels: State)	14.8	N/A	N/A	N/A	N/A
Resident Physicians per 100,000 Residents (Year: 2011; Region Levels: State)	35.8	N/A	N/A	N/A	N/A

Category 6 (Risk Management)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	90th %ile	50th %ile	10th %ile	Grade:10 Grade:0
Percent of Cancer Patients Dying in Hospital (Year: 2012; Region Levels: State)	23.1%	28.8%	22.5%	17.7%	14.6%
Adenoidectomies per 1,000 Children (Insurance Type: Commercial; Year: 2007-2010; Region Levels: State)	2.2	N/A	N/A	N/A	N/A
Tonsillectomies per 1,000 Children (Insurance Type: Overall; Year:	5.5	N/A	N/A	N/A	N/A

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2007-2010; Region Levels: State)					

Appendice[5]

Overall grade of Category 1 (Clinical effectiveness)

Example (Cleveland Clinic):

Take Cleveland Clinic as an example, the below chart shows the grades before calculating the final grade.

(The values for other categories are shown in the appendice[5].)

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Mortality rate	6.86%	2.60%	6.4%	4.0625	7.47608
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Hospital Day Ratio; Year: 2014; Region Levels: State)	1.00	1.42	1.22	8.591549	
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Inpatient Visit Ratio; Year: 2014; Region Levels: State)	1.00	1.60	0.97	6.0625	
Hospital Care Intensity Index, Last Two Years of Life, by Component (Component: Overall Index; Year: 2014; Region Levels: State)	1.00	1.45	1.10	7.586207	
All Surgical Discharges per 1,000 Medicare Enrollees, by Gender (Gender: Overall; Year: 2014; Region Levels: State)	72.7	82.6	N/A	N/A	

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CMS Hospital Compare Summary Quality Scores, by Condition (Condition: Overall; Year: 2007; Region Levels: State)	93.6%	96.6%	93.8%	9.710144928	
How do Patients Rate the Hospital Overall?, by Response (Response: Rating of 9 or 10 (High); Year: 2007; Region Levels: State)	62.68627451% ≈62.69%	70%	66%	9.428571429	
How do Patients Rate the Hospital Overall?, by Response (Response: Rating of 6 or Lower (Low); Year: 2007; Region Levels: State)	10.84314%≈10.84%	7%	12%	5.833333333	
Total 30-Day Prescription Fills per Beneficiary (Year: 2010; Region Levels: State)	48.8	55.9	N/A	N/A	
Percent Filling At Least One Prescription for a Beta-Blocker Following Heart Attack (Interval Following Heart Attack: 0-6 Months; Year: 2008-2010; Region Levels: State)	84.3%	89.7%	N/A	N/A	
Percent Filling At Least One Prescription for a Proton Pump Inhibitor (Year: 2010; Region Levels: State)	25.8%	31.5%	N/A	N/A	
Percent of Medicare Beneficiaries Filling Prescription for a High-Risk Medication (Year: 2012; Region Levels: State)	18.4%	11.1%	N/A	N/A	

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SNF Days per Decedent, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)	20.6	26.6	22.7	8.533835	

(For additional information such as year and region levels, refer to appendice[5].)
(refer to reference[3])

Category 2 (Clinical Audit)

Example (Cleveland Clinic):

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Total Medicare Reimbursements per Enrollee, by Adjustment Type (Adjustment Type: Price, Age, Sex & Race; Year: 2014; Region Levels: State)	$9,589	$11,221	N/A	N/A	9.740579
Total Medicare Reimbursements per Decedent, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)	$69,289	$86,616	$84,369	9.740579	
Total Part D Spending per Beneficiary (Year: 2010; Region Levels: State)	$2,670	$3,043	N/A	N/A	
Spending on Non-Prescription Services per Part D Beneficiary (Year: 2010; Region Levels: State)	$9,363	$11,415	N/A	N/A	

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Category 3 (Resource & Development)

Example (Cleveland Clinic):

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Inpatient Days per Decedent, by Interval Before Death and Level of Care Intensity (Interval Before Death: Last Two Years of Life; Level of Care Intensity: Overall; Year: 2014; Region Levels: State)	14.2	23	21.9	9.521739	8.220887
SNF Bed Inputs per 1,000 Decedents, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)	56.5	73	62.1	8.506849	
Hospital Bed Inputs per 1,000 Decedents, by Interval Before Death and Level of Care Intensity (Interval Before Death: Last Two Years of Life; Level of Care Intensity: Overall; Year: 2014; Region Levels: State)	38.9	55.2	60.1	10.88768	
Home Health	25.7	48.9	19.4	3.96728	

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Agency Visits per Decedent, by Interval Before Death (Interval Before Death: Last Two Years of Life; Year: 2014; Region Levels: State)					

Category 4 (Openness)

Example (Cleveland Clinic):

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Percent of Children in Study Population Insured by Medicaid (Year: 2007-2010; Region Levels: State)	39.5%	N/A	N/A	N/A	N/A

Category 5 (Education & Training)

Example (Cleveland Clinic):

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Percent of Medicare Enrollees Having Annual Ambulatory Visit to a Primary Care Clinician, by Race (Race: Overall; Year: 2014; Region Levels: State)	79.0%	85.3%	N/A	N/A	N/A

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Percent of Female Medicare Enrollees Age 67-69 Having At Least One Mammogram Every Two Years, by Race (Race: Overall; Year: 2014; Region Levels: State)	63.11%	74.8%	N/A	N/A	
Percent of Diabetic Medicare Beneficiaries Age 65-75 Receiving Three Recommended Tests (Year: 2012; Region Levels: State)	53.2%	63.5%	N/A	N/A	
FTE Hospital Employees per 1,000 Residents (Year: 2012; Region Levels: State)	14.8	N/A	N/A	N/A	
Resident Physicians per 100,000 Residents (Year: 2011; Region Levels: State)	35.8	N/A	N/A	N/A	

Category 6 (Risk Management)

Example (Cleveland Clinic):

(Values in red mean they are values of negative topics and therefore required to be calculated using the equation for negative data)

Topic	National average	Grade:10 Grade:0	Data	Grade of each topic	Overall grade
Percent of Cancer Patients Dying in Hospital	23.1%	14.6%	27.6%	5.28986	5.28986

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(Year: 2012; Region Levels: State)					
Adenoidectomies per 1,000 Children (Insurance Type: Commercial; Year: 2007-2010; Region Levels: State)	2.2	N/A	N/A	N/A	
Tonsillectomies per 1,000 Children (Insurance Type: Overall; Year: 2007-2010; Region Levels: State)	5.5	N/A	N/A	N/A	

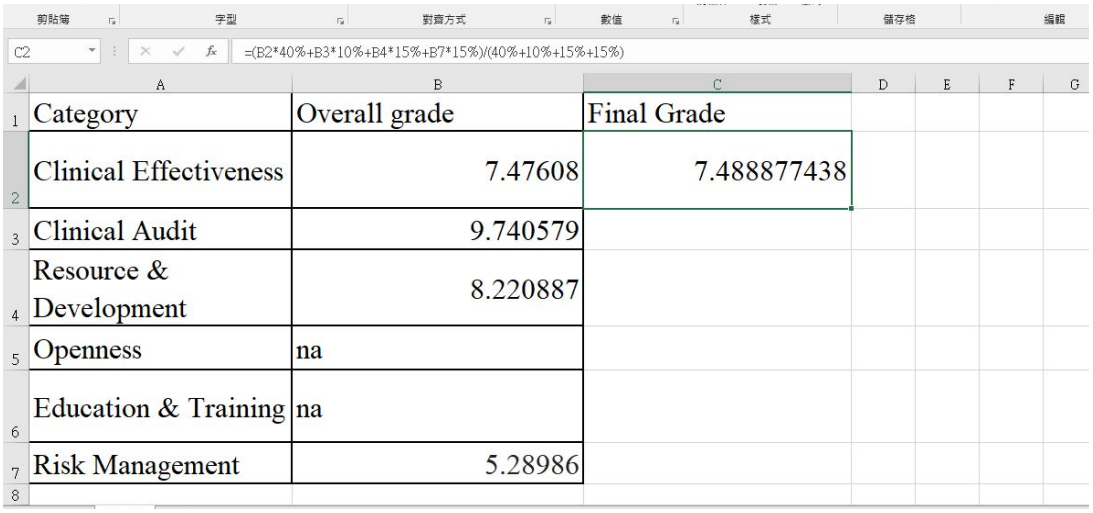
Appendice[6]

Final grade of Cleveland Clinic:

$$Final\ Grade = \frac{values\ of\ overall\ Grades \times their\ respective\ proportions(\%)}{the\ total\ of\ proportions}$$

$$Final\ Grade = \frac{7.47608\times15\%+9.740579\times10\%+8.220887\times15\%+5.28986\times15\%}{(15\%+10\%+15\%+15\%)}$$

$$= 7.448877438 \approx 7.45$$



	A	B	C	D	E	F	G
1	Category	Overall grade	Final Grade				
2	Clinical Effectiveness	7.47608	7.488877438				
3	Clinical Audit	9.740579					
4	Resource & Development	8.220887					
5	Openness	na					
6	Education & Training	na					
7	Risk Management	5.28986					
8							

Appendice[7]

Condition group and cause	ICD-10 codes	Age
Infections		
Tuberculosis	A15-A19, B90	0-74

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Selected invasive bacterial and protozoal infections	A38-A41, A46, A48.1, B50-B54, G00, G03, J02, L03	0-74
Hepatitis C	B17.1, B18.2	0-74
HIV/AIDS	B20-B24	All
Neoplasms		
Malignant neoplasm of lip, oral cavity and pharynx	C00-C14	0-74
Malignant neoplasm of oesophagus	C15	0-74
Malignant neoplasm of stomach	C16	0-74
Malignant neoplasm of colon and rectum	C18-C21	0-74
Malignant neoplasm of liver	C22	0-74
Malignant neoplasm of trachea, bronchus and lung	C33-C34	0-74
Malignant melanoma of skin	C43	0-74
Mesothelioma	C45	0-74
Malignant neoplasm of breast	C50	0-74
Malignant neoplasm of cervix uteri	C53	0-74
Malignant neoplasm of bladder	C67	0-74
Malignant neoplasm of thyroid gland	C73	0-74
Hodgkin's disease	C81	0-74
Leukaemia	C91, C92.0	0-44
Benign neoplasms	D10-D36	0-74
Nutritional, endocrine and metabolic		
Diabetes mellitus	E10-E14	0-49
Drug use disorders		
Alcohol related diseases, excluding external causes	F10, G31.2, G62.1, I42.6, K29.2, K70, K73, K74 (excl. K74.3-K74.5), K86.0	0-74
Illicit drug use disorders	F11-F16, F18-F19	0-74
Neurological disorders		
Epilepsy and status epilepticus	G40-G41	0-74
Cardiovascular diseases		

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Rheumatic and other valvular heart disease	I01-I09	0-74
Hypertensive diseases	I10-I15	0-74
Ischaemic heart disease	I20-I25	0-74
DVT with pulmonary embolism	I26, I80.1-I80.3, I80.9, I82.9	0-74
Cerebrovascular diseases	I60-I69	0-74
Aortic aneurysm and dissection	I71	0-74
Respiratory diseases		
Influenza (including swine flu)	J09-J11	0-74
Pneumonia	J12-J18	0-74
Chronic obstructive pulmonary disorder	J40-J44	0-74
Asthma	J45-J46	0-74
Digestive disorders		
Gastric and duodenal ulcer	K25-K28	0-74
Acute abdomen, appendicitis, intestinal obstruction, cholecystitis/lithiasis, pancreatitis, hernia	K35-K38, K40-K46, K80-K83, K85, K86.1-K86.9, K91.5	0-74
Genitourinary disorders		
Nephritis and nephrosis	N00-N07, N17-N19, N25-N27	0-74
Obstructive uropathy and prostatic hyperplasia	N13, N20-N21, N35, N40, N99.1	0-74
Maternal and infant		
Complications of perinatal period	P00-P96, A33	All
Congenital malformations, deformations and chromosomal anomalies	Q00-Q99	0-74
Unintentional injuries		
Transport Accidents	V01-V99	All
Accidental Injury	W00-X59	All
Intentional injuries		
Suicide and self inflicted injuries	X60-X84, Y10-Y34	All

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Homicide/Assault	X85-Y09, U50.9	All
Misadventures to patients during surgical and medical care	Y60-Y69, Y83-Y84	All

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