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Creative Project 1

Interpretation of Statistical Data for Health Care Providers

Case Study: Investigating Effective CPR

Our group project seeks to present a paradigm through which health care providers can consider incorporating statistical research into their practices. To this end, we have designed a three-part project, consisting of this text (a case study exploration), an informational pamphlet for providers about methods for parsing research, and an animation that seeks to engage providers in an immersive learning experience, based on new research data from the literature. In its entirety, we hope that our project can help close the gap between cutting-edge research and applied practices.

To contextualize this process of integration, we have decided to consider a case study. Our particular case study came out of the idea of studying processes occurring within the body during cardiac arrest and how new research in this field is being applied in patient care. This is an area of study that has exploded in recent years, with new conclusions suggesting that chest compressions are more important in determining success of resuscitation efforts than artificial breathing. Additional research has focused on cooling the body to a hypothermic state as a means to slow metabolism and cellular processes, thereby slowing down cell death resulting from systemic hypoxia. The American Heart Association in 2010 released modified guidelines for cardiopulmonary resuscitation (CPR) reflecting the results of new research in this field.

In order to learn more about the process by which this new data is becoming practice, we decided to pick a single article and study the design and implementation of the research. We chose an article titled “Effects of Compression Depth and Pre-Shock Pauses Predict Defibrillation Failure During Cardiac Arrest” by Dana P. Edelson, et al., published in the journal *Resuscitation* (2006) vol. 71, pages 137-145.

Edelson’s article discusses the effect that depth of chest compressions and length of pauses in the CPR process. Following the AHA CPR guidelines, a pause of a certain magnitude is necessary during CPR, because it is the moment of stillness that allows the rescuer to check for femoral or brachial pulses and return of spontaneous circulation (ROSC) after a cardiac arrest. Using conclusion of studies like the one Edelson created, the AHA has developed a new framework for providing EMS care that places the emphasis on supporting the circulation of blood (by continuing compressions without unnecessary pauses) and limiting the duration of necessary pauses (periods when providers are attempting to sense the cardiac rhythm.

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First, if we were to imagine ourselves health providers, instead of analytical chemistry students, we would familiarize ourselves with the article - read through at least once, possible several times. Our reading would seek to identify a few key questions; first we would want to know and understanding the article abstract. We should be able to easily summarize the abstract of our article.

Next we should take a critical look at the experimental design of the project. This includes factors such as sample size, geographic distribution of samples, whether the instruments being used to measure were sufficiently sensitive and whether the measuring techniques described in the procedure were adequate.

The next point it is important to develop is whether the data analysis performed by the authors makes sense and meets rigorous scientific standards. A basic understanding of statistics is necessary to evaluate these processes. In our article, the data analysis techniques utilized included;

For our case study article, the population was international, incorporating data from two diverse geographic regions; University of Chicago Hospitals in Chicago, United States, and patients in Akershus, Norway. The study took place between December 2002 and December 2005 in Chicago and March 2002 and August 2003 in Norway. Patients were enrolled in the study if they experienced a cardiac arrest as defined by a loss of pulse. Patients must have received cardiopulmonary resuscitation (CPR) to be enrolled in the study. In-patients who arrested in the emergency department or operating room were excluded from the study. The final criteria for enrollment was that the patient must have been experiencing ventricular fibrillation (VF) when they received the first shock. Personnel providing care were nurses and physicians in Chicago and Norway. In Norway care was also provided by EMTs. Defibrillators used in this study were in manual mode. Rescuers were trained in Advanced Cardiac Life Support (ACLS) and specially instructed how to use the equipment for the study. Data was recorded on memory cards and subsequently downloaded from the defibrillators.

Transcripts from the defibrillators were downloaded and annotated, allowing the researchers to empirically measure the timing. Researchers analyzed the cardiac rhythm immediately before and after the shock was delivered. They also analyzed the last 30 seconds of CPR provided before the shock, evaluating it for its quality. The analysis of researchers was reviewed by two physician investigators.

The period of the pre-shock pause was defined as the end of the last chest compression to the start of the shock. The defibrillation was declared a success if VF was terminated for at least 5 seconds as a result. Return of spontaneous circulation was defined as a return of an organized heart rhythm with palpable pulse and blood pressure, lasting for at least 20 minutes.

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Researchers used the application Stata Version 9.0 to perform statistical analysis of the data. Skewed data such as times and total shocks were reported as medians with interquartile ranges and were compared using a Wilcoxon rank sum test. Means were compared with a two-sided student's t-test and binary variables were compared with chi-squared analysis. A logistic regression analysis was performed to adjust for "possible confounding variables." Additionally an ordinal trend test was performed to find trends in proportions. The threshold for significance was set at $p < 0.05$.

As students of statistics, chemistry and science, it is our job to understand and be fluent in understanding what these more technical elements of experimental design mean. For clinicians, it is also important, because small errors or misrepresentations could have life-altering consequences for a patient. For health care providers, literature such as that which is presented in Edelson's article can be intimidating, although it is such studies that present the best opportunity for providers to use the best new techniques of science to benefit patients. In the next portion of our project we seek to demystify the statistical elements of the article by clarifying some important concepts that health care providers should become familiar with.

Mean- Commonly called the average is the is the sum of all the measured values divided by n, the number of measurements that were taken.

$$\overline{X} = \frac{\sum X}{N}$$

Standard Deviation- denoted by s, measures how closely the data values are clustered about the mean, or how far or close they are to the mean.

$$S = \sqrt{\frac{\Sigma (X - \overline{X})^2}{N}}$$

where S = the standard deviation of a sample,
Σ means "sum of,"
X = each value in the data set,
$\overline{X}$ = mean of all values in the data set,
N = number of values in the data set.

F-test- examines whether two standard deviations are significantly different for each other.

$$F = \frac{\text{explained variance}}{\text{unexplained variance}},$$

T-Test Case- is used to compare one mean value to another to decided whether there is a statistical difference between the two.

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$$t = \frac{\bar{X}_1 - \bar{X}_2}{S} \sqrt{\frac{n_1 n_2}{n_1 + n_2}}$$

$$SD_{pooled} = \sqrt{\frac{\sum (X_1 - \bar{X}_1)^2 + \sum (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}}$$

Confidence Interval- is used to determine the reliability of the calculated t- value. Comparison of the calculated t-value is compared to the official t-value table at a specific confidence interval for instance 95%confidence interval and at a specific value for the degrees of freedom (n-1). A 95% confidence interval means that if we were to repeat this experiment an infinite number of times 95% of the error bars in the data would contain the true population mean. If the calculated t-value is greater than t-table then it can be assumed that at that confidence interval there is statistical difference between the two sets of data.

Degrees of Freedom	Confidence Level %			
	50	90	95	98
1	1.000	6.314	12.706	31.821
2	0.816	2.920	4.303	6.965
3	0.756	2.353	3.182	4.541
4	0.741	2.132	2.776	3.747
5	0.727	2.015	2.571	3.365
6	0.718	1.943	2.447	3.143
7	0.711	1.895	2.365	2.998
8	0.706	1.860	2.306	2.896
9	0.703	1.833	2.262	2.821
10	0.700	1.812	2.228	2.764
15	0.691	1.753	2.131	2.602
20	0.687	1.725	2.086	2.528
25	0.684	1.708	2.060	2.485
30	0.683	1.697	2.042	2.457
40	0.681	1.684	2.021	2.423
60	0.679	1.671	2.000	2.390
120	0.677	1.658	1.980	2.358
** ∞	0.674	1.645	1.960	2.326

$$\bar{X} \pm t \frac{s}{\sqrt{n}}$$

As we can see in Edelson's article, mean compression depth was statistically significant with a p-value of .004. This means that there was a 99.6% chance that these results were not achieved randomly. Also in this data Edelson used a t- test case 2 because they had the group of patients from Chicago and the patients Norway to compare. In Edelson's Data Analysis section it says, "Means were compared with a two-study student t-test and binary variables were compared via chi-squared analysis."

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Binary variables are variables thats units can take on only two possible values and the chi-squared analysis is a distribution of the sum of the squares of a set of normally distributed random variables.

While reviewing the data compiled in the study, we were forced to conclude that as a whole the study was not without flaws. Overall, some of the reported p-values seemed larger than what we could with reasonable conscience call acceptable. The geographic disparity between the two study groups also seemed a weakness of the data. Can a useful comparison really be made between in-patient cardiac arrests at Chicago teaching hospitals and out-of-hospital arrests in the areas surrounding Norway's second largest city. Probably the Chicago data should have been compared to another urban data set, whereas the Norwegian data could have been usefully compared to Fairbanks or Anchorage, based on our similar climate, remoteness, and city size. Even though they did use the t test properly to compare the two separate groups we believe there were too many variables to use both groups data to support their hypothesis especially for a sample this small of only sixty subjects.

This example should illustrate right of the bat some of the challenges inherent to reading the scientific literature. Applying this literature to a field such as health care is especially challenging because of the subjective nature of the term "health" as well as the human factor - which is especially pervasive in the field of health. Any endeavor which seeks to better humanity must first come to terms with the fact that there is no one single method by which to accomplish this goal. Even among trained researchers and health care providers, a huge diversity exists, especially when the spectra is considered on an international scale.

And so - we are left in a situation with data with some error margin, and the unenviable task of taking our data and translating it into terms that health care providers will understand. Then providers must become converts of the data; they must believe that modifying their SOPs and guidelines will have a significant payoff in terms of improved patient care. Perhaps the most important (and irreplaceable) characteristic is an underlying quest to provide the most that we can to each patient. Ultimately it is this aim which drives us to find new methods and truths.