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Data Mining Physician Decisions for MRSA

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ABSTRACT

Methicillin-resistant Staphylococcus Aureus (MRSA) is a type of bacteria that is resistant to most antibiotics. These antibiotics include methicillin and other more common antibiotics such as Septra, Cipro, Penicillin and Amoxicillin. MRSA occurs most frequently among persons in hospitals and healthcare facilities (such as nursing homes and dialysis centers) who have weakened immune systems. It is the purpose of this study to survey physicians and to develop a decision model concerning the actual treatment of osteomyelitis (bone infection) with MRSA and to compare it to evidence from clinical studies.

Surveys were sent out to physicians and pharmacists (121 total). There is a noticeable pattern in physician treatment of MRSA with different antibiotics. In particular, recommendations for one antibiotic are automatically assumed for another. In contrast, we used SAS Text Miner to investigate the medical literature and other Internet sources to see how the drug manufacturers and clinical studies recommended antibiotics for treatment of MRSA. The macro, %tmfilter, was used to accumulate the study information. Text Miner allowed us to focus on the most relevant information. Physicians use different antibiotics for MRSA, and some of these antibiotics are ineffective; they are not recommended in any source to treat MRSA. After comparing the data set from our research, there is a noticeable difference between recommended and actual treatment. The two decision models developed from our study will reflect that difference. Actual treatment will result in a higher rate of amputation because of recurrence of the infection.

INTRODUCTION

MRSA is a type of bacteria (Gram Positive) that is resistant to most antibiotics. It is the purpose of this study to survey physicians and to compare the results to medical sources. Different tools from SAS such as Enterprise Guide, Enterprise Miner and Text Miner have been used in this project. We searched the literature (reference: Medline, www.pubmed.gov) for the antibiotics, Septra (Sulfamethoxyasole / Trimethoprim), Cleocin (Clindamycin), Vibramycin (Doxycycline), Zosyn (Piperacillin/ Tazobactam), Vancomycin (Various), Zyvox (Linezolid), Cipro (Ciprofloxacin), Levaquin (Levofloxacin), Rifampin/Novobiocin, and Rifampin/Bactrim, using the keywords, "MRSA" + antibiotic. We used %tmfilter to create a SAS dataset to search the web for information about treating MRSA with the above listed antibiotics. In the end, we compared the data set from our research in the literature with data from physicians and pharmacists.

METHOD

We requested a list of Physicians and Pharmacists from the Kentucky Board of Medical Licensure and the Kentucky Board of Pharmacists, respectively. We used systematic sampling from the list to send a survey to pharmacists. The surveys were sent out to all Infectious Disease specialists in Kentucky, and systematically sampled other specialists including Endocrinology Diabetes & Metabolism, Family Practice, Orthopedic Surgery and General Surgery. Pharmacists were selected randomly from the list of Kentucky Pharmacists. A total of 121 surveys were sent with a 10% response rate. More surveys will be sent, and the results updated as more responses are received. However, the returned surveys were relatively similar in responses.

We asked Physicians and Pharmacists to evaluate the antibiotics in their clinical experience as it relates to the treatment of MRSA-infected diabetic foot ulcers. A copy of the survey is provided in the appendix. Antibiotics included in the survey are Septra (Sulfamethoxyasole / Trimethoprim), Cleocin (Clindamycin), Vibramycin (Doxycycline), Zosyn (Piperacillin/ Tazobactam), Vancomycin (Various), Zyvox (Linezolid), Cipro (Ciprofloxacin), Levaquin (Levofloxacin), Rifampin/Novobiocin, and Rifampin/Bactrim. Physicians were asked if they ever used these antibiotics to treat MRSA, and if yes, what time period was used for the treatment of MRSA for Osteomyelitis (bone infection), Deep Tissue Wounds, and Surface Wounds. The surveys were transferred to three spreadsheets. The first one contained information related to the drugs used for the treatment of Osteomyelitis, the 2nd listed treatment for deep tissue wounds, and the last one for the treatment of Surface Wounds. We filtered the data to separate the results for specialists who used the antibiotics to treat MRSA.

We are also using NIS data. The NIS (Nationwide Inpatient Sample) is part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ), formerly the Agency for Health Care Policy and Research. ¹ (<http://www.ahrq.gov>)

We examined all occurrences of osteomyelitis in the National Inpatient Sample by filtering DRG 238, consisting of 20,177 inpatient visits without amputation from 2000-2004, the last year available. We identify patient severity based upon secondary diagnoses, and determine how severity relates to a patient's length of stay in the treatment of osteomyelitis. We also examined the identified procedures that are used to treat the infection. We use data mining techniques and exploratory analysis to examine the treatment differences.

We also investigated the medical literature and other Internet sources to see how the drug manufacturers and clinical studies recommended antibiotics for the treatment of MRSA, starting with Medline. We used the keywords MRSA + one choice of antibiotic, and repeated this step for all antibiotics in the list. We had no results from our search in Medline except for MRSA + Vancomycin and MRSA + Zyvox (Linezolid). The other antibiotics were not recommended nor approved in the medical literature. Then we searched using some popular search websites such as yahoo.com. The macro, %tmfilter from Enterprise Miner, was used to accumulate the study information from these other Internet sources. The code below shows an example of the macro, %tmfilter for searching "MRSA and Septra":

```
%tmfilter (url=%NRSTR(http://search.yahoo.com/search?p=Mrsa+Septra&fr=FP-tab-web-
t400&toggl=1&cop=&ei=UTF-8),
depth=2,
dir=c:\micro\dir1,
destdir=c:\micro\destdir1,
norestrict=1,
dataset=sasuser.sepral, numbers=3200);
```

TEXT MINER RESULTS

Using SAS Text Miner, we first clustered the website information. Table 1 shows an example of the clustered data set for MRSA + Zyvox. In this example, the first cluster (highlighted) is the only useful cluster. We filtered the cluster(s) to focus on the most relevant information.

Table 1. Clustering the SAS data set in Text Miner (MRSA + Zyvox)

#	Descriptive Terms	Freq	Percentage	RMS Std.
1	zyvox, + cause, + result, + infection, mrsa, back, previous, + version, + treat, + receive	30	0.1171875	0.1194487...
2	+ do, + see, + good, + create, + have, + do, + make, + will, + find, + not	68	0.265625	0.1481327...
3	+ preference, with, + sign, + add, + save, + tool, + help, + bookmark, guest, mail	139	0.54296875	0.0955115...
4	+ subscription, + find, + will, all, + service, more, + not, + site, + have, + home	19	0.07421875	0.1457691...

We may not always get wanted results from filtering the clusters. Table 2 shows us an example of poor result.

Table 2. Clustering the SAS data set in Text Miner (MRSA + Zosyn)

#	Descriptive Terms	Freq	Percentage	RMS Std.
1	+ search, + day, + school, navigation, + college, + fill, + word, + degree, rss, + reference	2	0.071428571...	.
2	+ do, + have, + do, + find, + not, + good, + term, + service, in, + web	26	0.928571428...	.
3	+ tag, + page, + beta, + bookmark, + tool, + sign, + preference, + web, + share, mail	0	0.0	.

Another way to filter our data set is to filter the Terms. Table 3 shows the result of filtering terms of MRSA + Zosyn.

Table 3. Term Filtered SAS data set in Text Miner (MRSA + Zosyn)

TERM ▲	Freq	# Documents	Keep	WEIGHT	Role	Attribute
mrsa	135	27	✓	0.52	Prop	Alpha
mrsa	5	4	✓	0.775	Adj	Alpha
zosyn	55	27	✓	0.484	Prop	Alpha
zosyn	3	3	✓	0.815	Noun	Alpha
zosyn@	6	6	✓	0.698	Prop	Unknown

We can use the results from filtering the terms and then re-cluster them. Table 4 is another example of re-clustering. It shows the results from clustering the data set from MRSA + Zyvox.

Table 4. Re-Clustering the SAS data set in Text Miner (MRSA + Zyvox)

#	Descriptive Terms	Freq	Percentage	RMS Std.
1	zyvox, + cause, + result, + infection, mrsa, back, previous, + version, + treat, + receive	30	0.1171875	0.1194487...

After clustering/filtering our data set, we will have the useful Internet files available. We studied the information from the filtered web sites and observed that Vancomycin is the only commonly used antibiotic for the treatment of MRSA for Osteomyelitis (bone infection) and deep wound with a specific time period of treatment. Zyvox is also recommended for MRSA; other antibiotics were suggested to use to treat MRSA, mostly for skin wounds from community-acquired MRSA as opposed to an infection acquired in the hospital. However, in some other (personal) websites, physicians have different opinions. They are treating (or trying to treat) MRSA with other antibiotics such as Septra, Cleocin, etc. We also have the same results from the survey.

SURVEY RESULTS

Figure 1 shows the length of treatment of Osteomyelitis using different antibiotics. Vancomycin has the highest percentage followed by Zyvox. They are both used for about six weeks to treat MRSA. In this graph, 0 is used to show the physicians who use the named antibiotics, but who didn't specify the length of treatment. We also see the highest percentage for Vancomycin and Zyvox in this part of the figure.

Figure 1. Time period in weeks used for the treatment of MRSA for Osteomyelitis

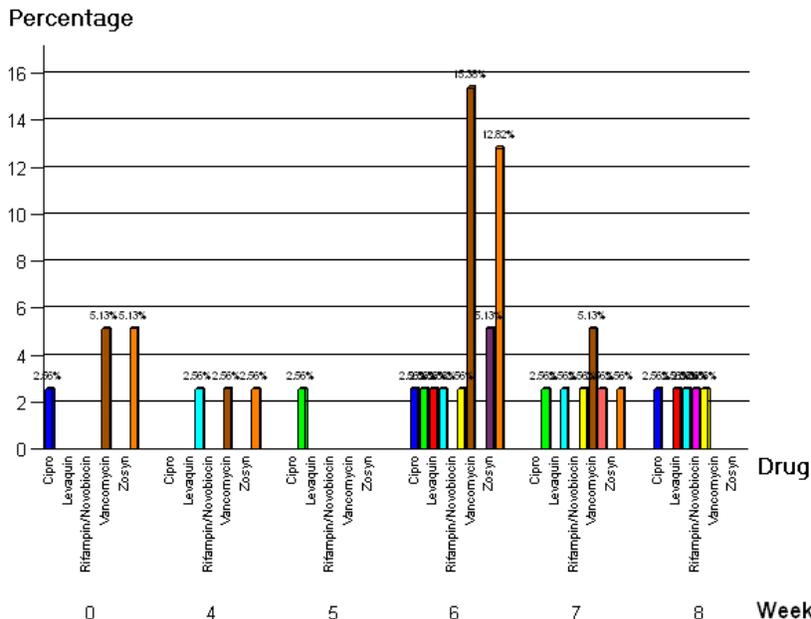


Figure 2 shows the statistics of physicians who have not used these antibiotics to treat MRSA. We see that Vancomycin and Zyvox have the lowest percentages since they are the most commonly used antibiotics to treat MRSA for osteomyelitis.

Figure 2. Physicians and Pharmacist who have not used these Antibiotics for Osteomyelitis

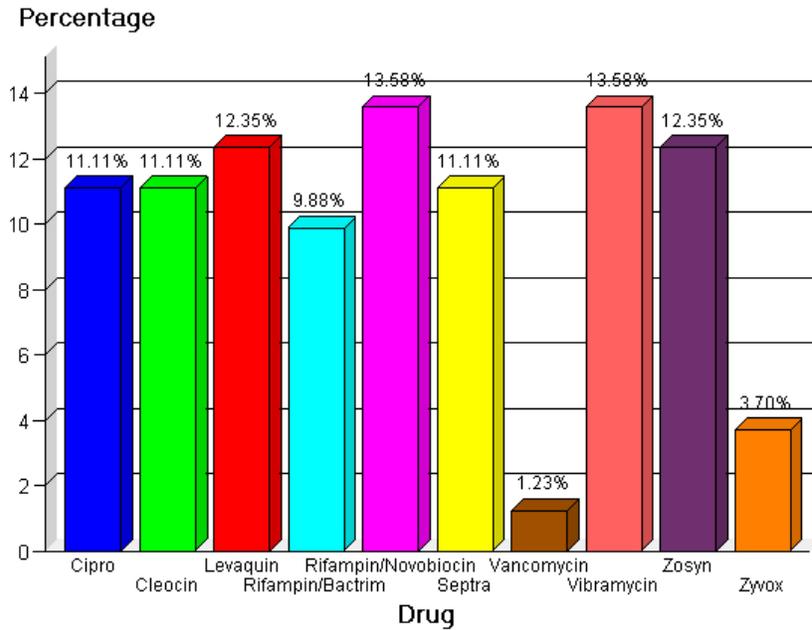


Figure 3 shows the length of treatment of Deep Tissue Wounds using different antibiotics. Zyvox has the highest percentage, with Vancomycin next. They are both used for about 14 days to treat MRSA. In this graph, 0 is used to show the physicians who use the named antibiotics but who didn't specify the length of treatment.

Figure 3. Time period in days used for the treatment of MRSA for Deep Tissue Wounds

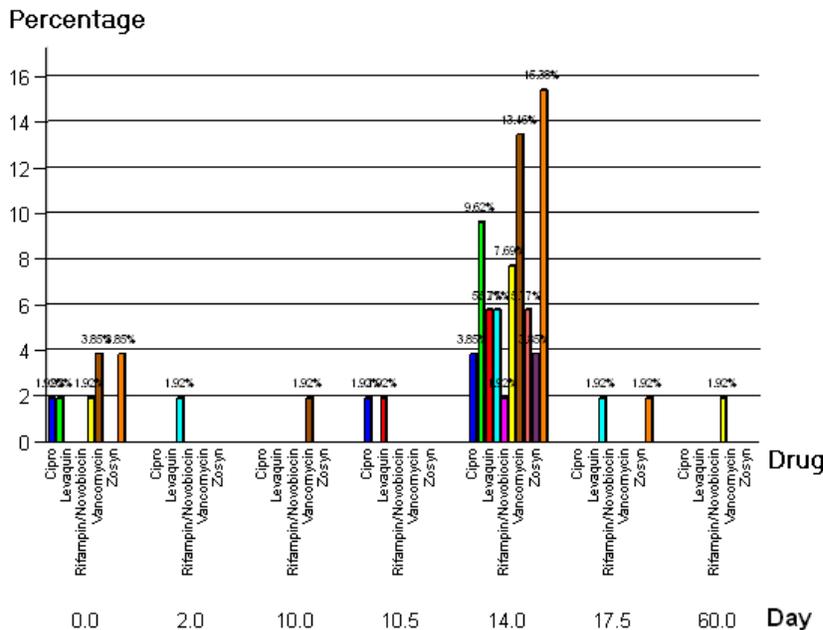


Figure 4 shows the statistics of physicians who have used these antibiotics to treat MRSA. We see that Vancomycin and Zyvox have the lowest percentage since they are the most commonly used antibiotics for MRSA for Deep Tissue Wounds.

Figure 4. Physicians and Pharmacist who have not used these Antibiotics for Deep Tissue Wounds

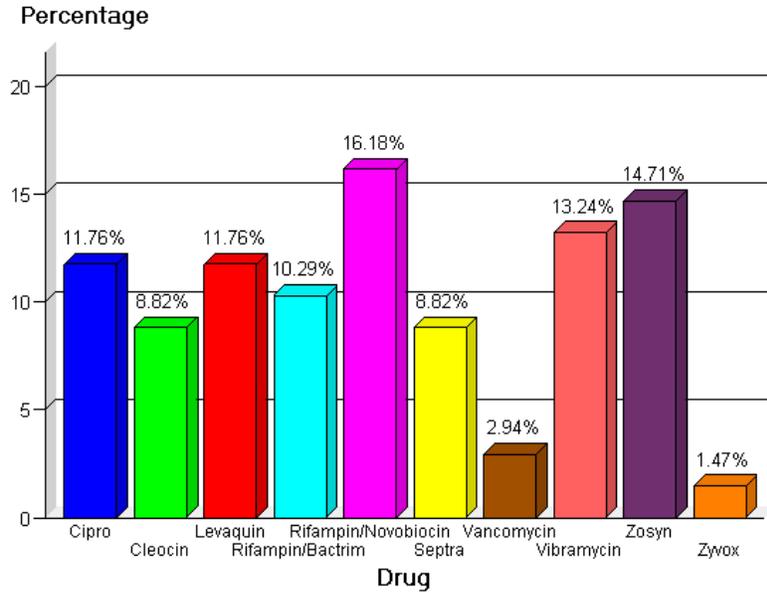
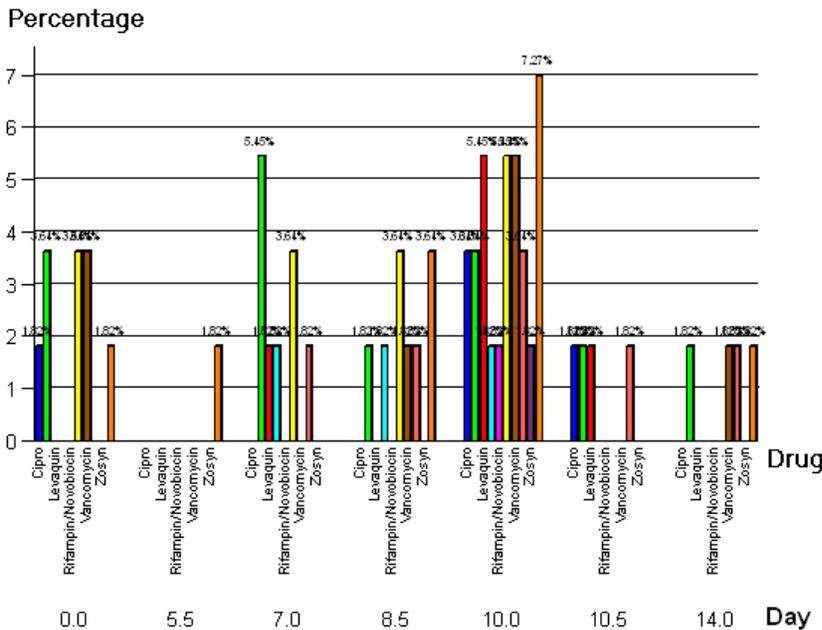


Figure 5 shows the length of treatment of Surface Wounds using different antibiotics. Zyvox has the highest percentage followed by Vancomycin, Septra and Levaquin. They are all used for about 10 days to treat MRSA. Cleocin has also the highest percentage for 7 days of treatment. We see other antibiotics are used for different lengths of treatment for Surface Wounds. In this graph, 0 is used to show the physicians who use the named antibiotics but didn't specify the length of treatment. We also see the highest percentage for Vancomycin, Septra and Cleocin in this part of the figure.

Figure 5. Time period in days used for the treatment of MRSA for Surface Wounds



SUMMARY OF NIS DATA

Of the 20,177 cases, 12,304 are identified as located in the lower leg and/or foot. The primary procedure for the treatment of osteomyelitis is venous catheterization for 5368 patients, antibiotic infusion for 417 patients, joint aspiration for 460 patients, drainage of skin and subcutaneous tissue for 860 patients, and blood transfusion for 384 patients. Only one patient had a primary procedure of 00.14, or an infusion of Zyvox for the treatment of the infection; three others had it as a secondary procedure out of the 20,177. 888 had previous leg or foot amputations; 57 had previous upper extremity amputations, suggesting recurrence requiring more aggressive treatment.

CONCLUSION

Physicians use different antibiotics for MRSA, and some of these antibiotics are ineffective; they are not recommended in any source to treat MRSA. After comparing the data set from our research, there is a noticeable difference between recommended and actual treatment. We can also see that physicians assume the same length of treatment for all antibiotics even if it is not validated in the literature. Actual treatment will result in a higher rate of amputation because of recurrence of the infection. No antibiotic treatment is FDA approved for osteomyelitis with MRSA; Zyvox is approved for treatment of MRSA in the skin and soft tissues only. However, previous amputation does not prevent recurrence of osteomyelitis; more aggressive antibiotic treatment should be considered.

APPENDIX-SURVEY TO PHYSICIANS

1. Please evaluate the following antibiotics in your clinical experience as it relates to the treatment of MRSA-infected diabetic foot ulcers:

Antibiotic	Use in Treatment of Surface Wounds for ____ days	Use in Treatment of Deep Tissue Wounds for ____ days	Use in Treatment of Osteomyelitis for ____ weeks	Never Use to treat MRSA
Septra (Sulfamethoxyazole/Trimethoprim)				
Cleocin (Clindamycin)				
Vibramycin (Doxycycline)				
Zosyn (Piperacillin/Tazobactam)				
Vancomycin (Various)				
Zyvox (Linezolid)				
Cipro (ciprofloxacin)				
Levaquin (levofloxacin)				
Rifampin/novobiocin				
Rifampin/bactrim				

2. I would supplement antibiotic treatment with hyperbaric oxygen for ____ Surface wounds, ____ Deep wounds, ____ Osteomyelitis
For Osteomyelitis, I would use hyperbaric oxygen for ____ weeks, for deep wounds for ____ weeks.
3. Do you consider the following factors when deciding upon the treatment of patients with infected foot ulcers caused by MRSA

	Important	Somewhat Important	Somewhat unimportant	Not important
Ability of Patient to carry out therapy				
Amount of help the Patient may need				
Physical Lay Out of Home, if antibiotic is to administered at home				
Cost to Payer				
Cost to Patient				
Length of Therapy				
Convenience to Patient or Care givers				

4. What is your Specialty? _____
5. Age? __31-38 __39-44 __45-49 __50-55 __56-60 __Over 60
6. Gender? __Male __Female
7. Additional Comments Concerning Treatment of MRSA:

REFERENCES

1. NIS; The NIS is part of the Healthcare Cost and Utilization Project (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ), formerly the Agency for Health Care Policy and Research.
(<http://www.ahrq.gov>)
2. Treatment Options for Osteomyelitis; An Investigation of the NIS Data, John C. Cerrito, Hamed Zahedi, Patricia Cerrito

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