**Bayesian analysis of season effect on surgical site infection after colorectal surgery**

**Introduction**

Colorectal surgery encompasses a broad range of surgical procedures used to treat conditions affecting the lower digestive tract, such as hemorrhoids, diverticulitis, and cancer. Many procedures can be performed using minimally invasive techniques such as laparoscopic or robotic surgery. It has been found that colorectal surgery has a high rate of surgical site infection.(Wick et al., 2011). There is a growing awareness of the need to reduce surgical site infection rate because its development has a negative impact on hospitalization length, quality of life, and other major postoperative outcomes, as well as cost.

Multiple factors was found to be associated with surgical site infection after colorectal surgery, such as Vitamin D(Berry et al., 2011). The reason is that Vitamin D is essential for the immune system, and patients who are deficient in Vitamin D have a significantly increased risk of cancer and infection(Herr et al., 2011). There have been few studies that look at the effect of season on patients. A dataset through *https://www.causeweb.org/tshs/season-effect/* was identified to conduct a Bayesian analysis of seasonal effect on surgical infection rate. I aim to test the hypothesis that season is an important factor and evaluate the effect of each season on surgical site infection after colorectal surgery.

**Methods**

The dataset contains 14 variables with 2919 observations. The surgical site infection is a binary variable (yes/ no). Other variables includes age, gender, race, BMI(), ASA status, diabetes status, chronic renal failure, etc. The data dictionary is shown in Table S1.

An ordinary Bayesian logistic regression was performed to test the research hypothesis. I modeled through the canonical logit link function. The following prespecified covariates were selected as potential confounders to adjust for the primary analysis for seasonal effects: age, gender, race, BMI, ASA status, diabetes stats, chronic renal failure status, preoperative usage of steroids, emergency case, duration of surgery, and red blood cell transfusion. Sum to zero constraint is performed for the categorical predictors. The details were shown below.

An independent non-informative normal prior was selected for each regression coefficient.

The posterior samples of were draw from MCMC.

The Bayesian statistical analysis was performed using R (4.2.2) through “rjags” package.

**Results**

The observed rates of surgical infection was 6.8%, 9.9%, 7.3%, and 8.2% for those having colorectal surgery during spring, summer, fall, and winter respectively (Figure 1).

Figure 1

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The pairwise comparisons among seasons (totally 6 comparisons) were shown in Table 1. The increased risks of surgical infection were observed from Fall vs Spring, and Winter vs Spring. The rest comparisons were found to be lowered risks of surgical infection. Among these comparisons, we found two significant differences, fall vs summer and spring vs summer. The estimated odds ratio of surgical infection between Fall and Summer is 0.714 with 95% credible sets [0.499, 0.986]. The similar significant trend is observed for Spring vs Summer with odds ratio 0.611 (95% credible sets [0.370, 0.932]).

Table 1. Primary results

|  |  |  |
| --- | --- | --- |
| Comparison | Odds ratio | 95% credible sets |
| Fall vs Winter | 0.926 | [0.622, 1.326] |
| Fall vs Spring | 1.220 | [0.739, 1.930] |
| Fall vs Summer | 0.714 | [0.499, 0.986] |
| Winter vs Spring | 1.344 | [0.807, 2.145] |
| Winter vs Summer | 0.787 | [0.543, 1.097] |
| Spring vs Summer | 0.611 | [0.370, 0.932] |

The posterior estimates of coefficients are shown in Table 2. We found seasons Fall and Spring have negative impact on surgical infection, while season Summer and Winter have positive impact on surgical infection. Besides, there was a significant positive association between diabetes status, duration of surgery and surgical infection rate.

Table 1. Posterior estimates of coefficient estimates

|  |  |  |  |
| --- | --- | --- | --- |
|  | Coefficient estimates (Mean) | Standard deviation | 95% credible sets |
| Intercept | -3.647 | 0.442 | [-4.522, -2.794] |
| Age | 0.026 | 0.005 | [-0.010, 0.009] |
| Gender (Female) | 0.052 | 0.138 | [-0.219, 0.323] |
| BMI | 0.009 | 0.010 | [-0.012, 0.029] |
| Diabetes | 0.572 | 0.161 | [0.253, 0.886] |
| Chronic renal failure status | 0.326 | 0.290 | [-0.262, 0.875] |
| preoperative usage of steroids | 0.300 | 0.228 | [-0.159, 0.735] |
| Emergency case | 0.562 | 0.295 | [-0.036, 1.121] |
| Duration of surgery | 0.210 | 0.035 | [0.142, 0.279] |
| Red blood cell transfusion | 0.0001 | 0.0002 | [-0.0003, 0.0004] |
| Race | | | |
| White | -0.001 | 0.168 | [-0.316, 0.343] |
| Black | -0.223 | 0.230 | [-0.683, 0.221] |
| Others | 0.225 | 0.278 | [-0.350, 0.742] |
| ASA status | | | |
| Normal | 0.380 | 0.312 | [-0.266, 0.957] |
| Mild | -0.165 | 0.160 | [-0.472, 0.155] |
| Severe | -0.154 | 0.152 | [-0.446, 0.152] |
| Constant threat | -0.062 | 0.276 | [-0.621, 0.462] |
| Seasonal effects | | | |
| Fall | -0.070 | 0.121 | [-0.310, 0.164] |
| Winter | 0.026 | 0.125 | [-0.221, 0.267] |
| Spring | -0.238 | 0.165 | [-0.573, 0.074] |
| Summer | 0.282 | 0.110 | [0.066, 0.497] |

**Discussion**

We found increased risk of surgical infection after colorectal surgery during Summer and winter, and lower risk of surgical infection during Fall and Spring. The higher risk of surgical infection is significant during Summer. The result of pairwise comparison suggests that patients are more likely to experience surgical infection in summer compared with spring and fall. Besides the primary findings, we also found duration of surgery and diabetes are important factors that contribute to infection.

Understanding the mechanisms underlying seasonality of colorectal surgical infections will aid in the development of prevention strategies. For example, high temperature and humidity may promote bacterial growth in the surgical areas. For those with diabetes, it may be better to lower the surgery duration and take more comprehensive ways to prevent infections.

We used Bayesian methods instead of frequentist methods to do the analysis to incorporate the benefits. Within a solid decision theoretical framework, it provides a natural and principled way of combining prior information with data. If we have physician guess or previous studies, we can borrow the historical information into our study to strengthen the findings. The future work of this study is to consult with physician to add information into priors of seasonal effects.

**Reference**

Berry, D. J., Hesketh, K., Power, C., and Hyppönen, E. (2011). Vitamin D status has a linear association with seasonal infections and lung function in British adults. *British Journal of Nutrition* **106**, 1433-1440.

Herr, C., Greulich, T., Koczulla, R. A.*, et al.* (2011). The role of vitamin D in pulmonary disease: COPD, asthma, infection, and cancer. *Respiratory research* **12**, 1-9.

Wick, E. C., Hirose, K., Shore, A. D.*, et al.* (2011). Surgical site infections and cost in obese patients undergoing colorectal surgery. *Archives of surgery* **146**, 1068-1072.

Table S1. Data dictionary

Table

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**Appendix**