Question 5:

a. Fit 1 is below:

```
> fit1=glm(SoreThroat$Y~SoreThroat$D+SoreThroat$T,data=SoreThroat, family = binomial(link = "logit"))
> summary(fit1)

Call:
glm(formula = SoreThroat$Y ~ SoreThroat$D + SoreThroat$T, family = binomial(link = "logit"),
    data = SoreThroat)

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.41734    1.09457  -1.295  0.19536
SoreThroat$D  0.06868    0.02641   2.600  0.00931 **
SoreThroat$T -1.65895    0.92285  -1.798  0.07224 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 46.180  on 34  degrees of freedom
Residual deviance: 30.138  on 32  degrees of freedom
AIC: 36.138

Number of Fisher Scoring iterations: 5
```

b. Fit 2 is below:

```
> fit2=glm(SoreThroat$Y~SoreThroat$D+SoreThroat$T+SoreThroat$T:SoreThroat$D,data=SoreThroat, family = binomial(link = "logit"))
> summary(fit2)

Call:
glm(formula = SoreThroat$Y ~ SoreThroat$D + SoreThroat$T + SoreThroat$T:SoreThroat$D,
    family = binomial(link = "logit"), data = SoreThroat)

Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)                0.04979    1.46940   0.034   0.9730
SoreThroat$D               0.02848    0.03429   0.831   0.4062
SoreThroat$T              -4.47224    2.46707  -1.813   0.0699 .
SoreThroat$D:SoreThroat$T  0.07460    0.05777   1.291   0.1966
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 46.180  on 34  degrees of freedom
Residual deviance: 28.321  on 31  degrees of freedom
AIC: 36.321

Number of Fisher Scoring iterations: 6
```

c. The prediction equation for fit 2 is:
Logit(p(Y=1)) =0.049+0.028xDuration-4.472xType+0.074x(D*T)

For Duration (D):
For every one minute increase in surgery, the estimated odds of sore throat is increased by exp (0.028) =1.02 times while keeping other variables held constant.

For Type of device used (T):
For every other type of device used in surgery, the estimated odds of sore throat is increased by exp (-4.472) =0.011 times while keeping other variables held constant.

For Duration in Duration interacting with Type of device:
For every one-minute increase in surgery for a fixed type of device, the estimated odds of sore throat is increased by exp (0.077) =1.077 times while keeping other variables held constant.

For Type of device used in Duration interacting with Type of device:
For every change in device type used while keeping duration fixed, the estimated odds of sore throat is increased by exp (-4.423) =0.011 times while keeping other variables held constant.

d. LRT test:

```
> anova(fit1,fit2,test="LRT")
Analysis of Deviance Table

Model 1: SoreThroat$Y ~ SoreThroat$D + SoreThroat$T
Model 2: SoreThroat$Y ~ SoreThroat$D + SoreThroat$T + SoreThroat$T:SoreThroat$D
  Resid. Df Resid. Dev Df Deviance Pr(>Chi)
1        32     30.138
2        31     28.321  1   1.8169   0.1777
>
```

From above, the model with interaction term does not seems adequate in predicting the sore throat and hence fit 1 without interaction seems more adequate with p-value 0.177 > 0.10 at 10% level of significance with deviance of 1.8 for DF=1.

e. Fit 1 is selected without interaction term from comparing above.

```
> fit1=glm(SoreThroat$Y~SoreThroat$D+SoreThroat$T,data=SoreThroat, family = binomial(link = "logit"))
> summary(fit1)

Call:
glm(formula = SoreThroat$Y ~ SoreThroat$D + SoreThroat$T, family = binomial(link = "logit"),
    data = SoreThroat)

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.41734    1.09457  -1.295  0.19536
SoreThroat$D  0.06868    0.02641   2.600  0.00931 **
SoreThroat$T -1.65895    0.92285  -1.798  0.07224 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 46.180  on 34  degrees of freedom
Residual deviance: 30.138  on 32  degrees of freedom
AIC: 36.138

Number of Fisher Scoring iterations: 5
```

For Duration (D):
For every one-minute increase in surgery, the estimated odds of sore throat is increased by exp (0.068) =1.07 times while keeping other variables held constant.

For Type of device used (T):
For every other type of device used in surgery, the estimated odds of sore throat is increased by exp (-1.658) =0.190 times while keeping other variables held constant.

f. Predictive power for model fit 1:

```
> predicted1 <- as.numeric(fitted(fit1) > phat)
> xtabs(~SoreThroat$Y + predicted1)
             predicted1
SoreThroat$Y  0  1
           0 10  3
           1  4 18
```

Fit 1 predicts 10 cases with no sore throats out of 13 and 18 cases with sore throats out of 22.

Predictive model for fit2:

```
> predicted2 <- as.numeric(fitted(fit2) > phat)
> xtabs(~SoreThroat$Y + predicted2)
             predicted2
SoreThroat$Y  0  1
           0  9  4
           1  2 20
```

Fit 2 predicts 9 cases with no sore throats out of 13 and 20 cases with sore throats out of 22.

Fit 1 seems adequate with better prediction compared with observed and fitted values.

g. The predicted value is below:

```
[1] -0.39777
```

The probability for 39 minutes of duration of surgery with tracheal tube type of device the predicted value is -0.3977.

h. The predicted value is below:

```
[1] 1.26118
```

The probability for a patient underwent surgery and experienced sore throat with duration of surgery as 39 minutes when a laryngeal mask airway used has a predicted value of 1.261.

i. The predicted value for tracheal tube as device seems much lower than the predicted value for laryngeal mask as a device for sore throat as the patient with sore throat were much higher for mask airway than tube device type.