In [1]:

```
import pybaseball as pyb
from pybaseball import statcast, pitching_stats, playerid_lookup, stat
import numpy as np
import math
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import glob
import os
import re
import unicodedata
from datetime import datetime
from itertools import groupby
from operator import itemgetter
from sklearn.preprocessing import OneHotEncoder, StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.metrics import accuracy_score, recall_score, precision_sc
from sklearn.metrics import ConfusionMatrixDisplay
from sklearn.metrics import classification_report
from sklearn.pipeline import Pipeline
#from imblearn.over_sampling import SMOTE
from catboost import CatBoostClassifier
```

```
C:\Users\johns\anaconda3\Lib\site-packages\pandas\core\arrays\masked.py:6
0: UserWarning: Pandas requires version '1.3.6' or newer of 'bottleneck'
(version '1.3.5' currently installed).
  from pandas.core import (
```

In [2]:

```
complete_100_df = pd.read_csv('~/Documents/Flatiron/Project_5_/data/co
```

In [24]:

```
complete_100_df
```

Out[24]:

	Name	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	relea
0	adam wainwright	41.0	425794	2023	CH	91	
1	adam wainwright	41.0	425794	2023	CS	3	
2	adam wainwright	41.0	425794	2023	CU	545	
3	adam wainwright	41.0	425794	2023	FC	403	
4	adam wainwright	41.0	425794	2023	FF	176	
...	...	...	...	...	...	...	
21386	jeff samardzija	23.0	502188	2008	FS	99	
21387	jeff samardzija	23.0	502188	2008	IN	6	
21388	jeff samardzija	23.0	502188	2008	PO	1	
21389	jeff samardzija	23.0	502188	2008	SI	83	
21390	jeff samardzija	23.0	502188	2008	SL	45	

21391 rows × 16 columns

In [26]:

```
complete_100_df['Surgery'].value_counts()
```

Out[26]:

```
Surgery
0.0    16389
1.0     5002
Name: count, dtype: int64
```

In [23]:

```
wainwright_df = complete_100_df[complete_100_df['Name'] == 'adam wainw
wainwright_df
```

Out[23]:

	Name	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	releas
0	adam wainwright	41.0	425794	2023	CH	91	
1	adam wainwright	41.0	425794	2023	CS	3	
2	adam wainwright	41.0	425794	2023	CU	545	
3	adam wainwright	41.0	425794	2023	FC	403	
4	adam wainwright	41.0	425794	2023	FF	176	
...	...	...	...	...	...	...	
20627	adam wainwright	26.0	425794	2008	FC	395	
20628	adam wainwright	26.0	425794	2008	FF	101	
20629	adam wainwright	26.0	425794	2008	IN	4	
20630	adam wainwright	26.0	425794	2008	PO	2	
20631	adam wainwright	26.0	425794	2008	SI	879	

95 rows × 16 columns

In [13]:

```python
# Correcting the approach to ensure 'Surgery' is 1.0 from the surgery y
complete_100_df['Surgery'] = complete_100_df.apply(lambda row: 1.0 if

complete_100_df
```

Out[13]:

	Name	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	relea
0	adam wainwright	41.0	425794	2023	CH	91	
1	adam wainwright	41.0	425794	2023	CS	3	
2	adam wainwright	41.0	425794	2023	CU	545	
3	adam wainwright	41.0	425794	2023	FC	403	
4	adam wainwright	41.0	425794	2023	FF	176	
...	...	...	...	...	...	...	
21386	jeff samardzija	23.0	502188	2008	FS	99	
21387	jeff samardzija	23.0	502188	2008	IN	6	
21388	jeff samardzija	23.0	502188	2008	PO	1	
21389	jeff samardzija	23.0	502188	2008	SI	83	
21390	jeff samardzija	23.0	502188	2008	SL	45	

21391 rows × 16 columns

This ensures that we are only counting for 'Surgery' for the year of surgery, and all years going forward.

In [17]:

```python
filtered_rows = complete_100_df[(complete_100_df['Surgery'] == 1.0) &
filtered_rows
```

Out[17]:

Name	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	release_speed_

In [19]:

```python
pd.set_option('display.max_rows', None)
```

In [22]:

```
pd.reset_option('display.max_rows')
```

In [27]:

```
complete_100_df['TJ Surgery Year'].fillna(0.0, inplace=True)
```

```
C:\Users\johns\AppData\Local\Temp\ipykernel_8568\550959113.py:1: FutureWa
rning: A value is trying to be set on a copy of a DataFrame or Series thr
ough chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never wo
rk because the intermediate object on which we are setting values always
behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(valu
e) instead, to perform the operation inplace on the original object.


  complete_100_df['TJ Surgery Year'].fillna(0.0, inplace=True)
```

In [7]:

```python
"""
# Fill NaN in 'TJ Surgery Year' with 0.0
complete_100_df['TJ Surgery Year'].fillna(0.0, inplace=True)

# Update 'Surgery' based on 'season' and 'TJ Surgery Year'
complete_100_df['Surgery'] = complete_100_df.apply(
    lambda row: 1.0 if row['season'] >= row['TJ Surgery Year'] and row
)

# Verify the changes
print(complete_100_df[['Name', 'season', 'TJ Surgery Year', 'Surgery']

# Check the value counts again
print(complete_100_df['Surgery'].value_counts())
"""
```

```
C:\Users\johns\AppData\Local\Temp\ipykernel_32520\2928425957.py:2: Future
Warning: A value is trying to be set on a copy of a DataFrame or Series t
hrough chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never wo
rk because the intermediate object on which we are setting values always
behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(valu
e) instead, to perform the operation inplace on the original object.


  complete_100_df['TJ Surgery Year'].fillna(0.0, inplace=True)

              Name  season  TJ Surgery Year  Surgery
0  adam wainwright    2023           2011.0      1.0
1  adam wainwright    2023           2011.0      1.0
2  adam wainwright    2023           2011.0      1.0
3  adam wainwright    2023           2011.0      1.0
4  adam wainwright    2023           2011.0      1.0
Surgery
0.0    16389
1.0     5002
Name: count, dtype: int64
```

In [28]:

```
complete_100_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 21391 entries, 0 to 21390
Data columns (total 16 columns):
 #   Column                          Non-Null Count  Dtype  
---  ------                          --------------  -----  
 0   Name                            21391 non-null  object 
 1   Age                             21391 non-null  float64
 2   pitcher                         21391 non-null  int64  
 3   season                          21391 non-null  int64  
 4   pitch_type                      21391 non-null  object 
 5   season_total_count_by_pitch_type 21391 non-null  int64  
 6   release_speed_weighted_avg      21391 non-null  float64
 7   release_pos_x_weighted_avg      21391 non-null  float64
 8   release_pos_y_weighted_avg      21391 non-null  float64
 9   release_pos_z_weighted_avg      21391 non-null  float64
 10  vx0_weighted_avg                21391 non-null  float64
 11  vy0_weighted_avg                21391 non-null  float64
 12  vz0_weighted_avg                21391 non-null  float64
 13  Throws                          21391 non-null  int64  
 14  Surgery                         21391 non-null  float64
 15  TJ Surgery Year                 21391 non-null  float64
dtypes: float64(10), int64(4), object(2)
memory usage: 2.8+ MB
```

Can probably drop 'Name' and 'TJ Surgery Year' columns

In [66]:

```
funky_df = complete_100_df.drop(columns=['Name', 'TJ Surgery Year'])
```

In [67]:

```
funky_df
```

Out[67]:

	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	release_speed_w
0	41.0	425794	2023	CH	91	
1	41.0	425794	2023	CS	3	
2	41.0	425794	2023	CU	545	
3	41.0	425794	2023	FC	403	
4	41.0	425794	2023	FF	176	
...	...	...	...	...	...	
21386	23.0	502188	2008	FS	99	
21387	23.0	502188	2008	IN	6	
21388	23.0	502188	2008	PO	1	
21389	23.0	502188	2008	SI	83	
21390	23.0	502188	2008	SL	45	

21391 rows × 14 columns

In [68]:

```
funky_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 21391 entries, 0 to 21390
Data columns (total 14 columns):
 #   Column                            Non-Null Count  Dtype  
---  ------                            --------------  -----  
 0   Age                               21391 non-null  float64
 1   pitcher                           21391 non-null  int64  
 2   season                            21391 non-null  int64  
 3   pitch_type                        21391 non-null  object 
 4   season_total_count_by_pitch_type  21391 non-null  int64  
 5   release_speed_weighted_avg        21391 non-null  float64
 6   release_pos_x_weighted_avg        21391 non-null  float64
 7   release_pos_y_weighted_avg        21391 non-null  float64
 8   release_pos_z_weighted_avg        21391 non-null  float64
 9   vx0_weighted_avg                  21391 non-null  float64
 10  vy0_weighted_avg                  21391 non-null  float64
 11  vz0_weighted_avg                  21391 non-null  float64
 12  Throws                            21391 non-null  int64  
 13  Surgery                           21391 non-null  float64
dtypes: float64(9), int64(4), object(1)
memory usage: 2.4+ MB
```

In [69]:

```
funky_df['pitch_type'].value_counts()
```

Out[69]:

```
pitch_type
FF    3641
CH    3356
SI    3286
SL    2775
CU    2670
FC    1625
IN    1605
PO    1045
KC     525
FS     390
ST     129
FA     124
EP      90
CS      52
SV      29
KN      25
AB      14
SC      10
Name: count, dtype: int64
```

In [70]:

```
funky_df['release_pos_y_weighted_avg'].value_counts()
```

Out[70]:

```
release_pos_y_weighted_avg
54.500000    14019
54.580000        7
54.780000        6
54.360000        6
54.160000        6
             ...  
54.247143        1
54.289964        1
54.083586        1
54.099168        1
55.031195        1
Name: count, Length: 6936, dtype: int64
```

In [58]:

```
fa_rows = funky_df[funky_df['pitch_type'] == 'FA']
```

In [59]:

```
fa_rows
```

Out[59]:

	Age	pitcher	season	pitch_type	season_total_count_by_pitch_type	release_speed_w
67	35.0	477132	2023	FA	1	
168	33.0	543101	2023	FA	1	
196	32.0	543475	2023	FA	1	
1869	37.0	425844	2021	FA	9	
2892	36.0	425844	2020	FA	57	
...	...	...	...	...	...	
20964	23.0	444836	2008	FA	2	
21019	27.0	446454	2008	FA	7	
21211	25.0	456043	2008	FA	20	
21219	22.0	456501	2008	FA	1	
21228	26.0	456589	2008	FA	6	

124 rows × 14 columns

Try condensing pitch_type before the pivot and compare.

In [60]:

```
condensed_pitch_type_df = funky_df
```

In [61]:

```
pitch_type_mapping = {
    'FF': 'FB', 'SI': 'FB', 'FC': 'FB', 'FA': 'FB',
    'CH': 'OS', 'FS': 'OS', 'FO': 'OS', 'SC': 'OS', 'PO': 'OS',
    'CU': 'BB', 'KC': 'BB', 'CS': 'BB',
    'SL': 'SB', 'ST': 'SB', 'SV': 'SB', 'KN': 'SB',
    'EP': 'OT', 'AB': 'OT', 'IN': 'OT'
}

condensed_pitch_type_df['pitch_type_group'] = condensed_pitch_type_df[
```

In [63]:

```
grouped_df = condensed_pitch_type_df.groupby(['Age', 'pitcher', 'seaso
    season_total_count_by_pitch_type=('season_total_count_by_pitch_typ
    release_speed_weighted_avg=('release_speed_weighted_avg', 'mean'),
    release_pos_x_weighted_avg=('release_pos_x_weighted_avg', 'mean'),
    release_pos_y_weighted_avg=('release_pos_y_weighted_avg', 'mean'),
    release_pos_z_weighted_avg=('release_pos_z_weighted_avg', 'mean'),
    vx0_weighted_avg=('vx0_weighted_avg', 'mean'),
    vy0_weighted_avg=('vy0_weighted_avg', 'mean'),
    vz0_weighted_avg=('vz0_weighted_avg', 'mean'),
    Throws=('Throws', 'first'),  # Assuming Throws doesn't change with
    Surgery=('Surgery', 'first')  # Assuming Surgery doesn't change wi
).reset_index()

```

In [64]:

```
grouped_df
```

Out[64]:

	Age	pitcher	season	pitch_type_group	season_total_count_by_pitch_type	release_sp
0	19.0	518516	2009	BB	42	
1	19.0	518516	2009	FB	98	
2	19.0	518516	2009	OS	12	
3	19.0	518516	2009	OT	4	
4	19.0	605164	2012	BB	1	
...	...	...	...	...	...	
14707	47.0	119469	2010	OS	306	
14708	49.0	119469	2012	BB	90	
14709	49.0	119469	2012	FB	628	
14710	49.0	119469	2012	OS	301	
14711	49.0	119469	2012	OT	8	

14712 rows × 14 columns

In [65]:

```
grouped_df['release_pos_y_weighted_avg'].value_counts()
```

Out[65]:

```
release_pos_y_weighted_avg
54.500000    9540
54.160000       3
53.970000       3
53.980000       3
54.110000       3
             ... 
54.281383       1
54.396867       1
53.962602       1
54.059634       1
55.724512       1
Name: count, Length: 5138, dtype: int64
```

In [72]:

```
def pivot_metrics(df, index_cols, pivot_col, value_cols):
    """
    Pivot the DataFrame for the specified pivot column.
    :param df: DataFrame to pivot.
    :param index_cols: List of columns to use as the index.
    :param pivot_col: Column to pivot on.
    :param value_cols: Columns whose values are to be spread across pi
    :return: Pivoted DataFrame.
    """
    pivoted_dfs = []
    for value_col in value_cols:
        # Pivot each metric column separately and rename to include th
        pivoted_df = df.pivot_table(index=index_cols, columns=pivot_co
        pivoted_df.columns = [f"{col}_{value_col}" if col not in index_
        pivoted_dfs.append(pivoted_df)

    # Merge all the pivoted metric DataFrames on the index columns
    from functools import reduce
    final_df = reduce(lambda left, right: pd.merge(left, right, on=ind
    return final_df

# Define the base columns and the metrics you want to pivot
index_cols = ['pitcher', 'season', 'Age', 'Throws', 'Surgery']
pivot_col = 'pitch_type_group'
value_cols = ['release_speed_weighted_avg', 'release_pos_x_weighted_av

# Pivot the DataFrame
cond_pivoted_df = pivot_metrics(grouped_df, index_cols, pivot_col, val

cond_pivoted_df.head()
```

Out[72]:

	pitcher	season	Age	Throws	Surgery	BB_release_speed_weighted_avg	FB_release_spe
0	110683	2008	37.0	1	0.0	75.425843	
1	110683	2009	38.0	1	0.0	78.181818	
2	110683	2010	39.0	1	0.0	74.666667	
3	110683	2011	40.0	1	0.0	76.885714	
4	110683	2012	41.0	1	0.0	76.427273	

5 rows × 40 columns

In [73]:

```
cond_pivoted_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3688 entries, 0 to 3687
Data columns (total 40 columns):
 #   Column                        Non-Null Count  Dtype  
---  ------                        --------------  -----  
 0   pitcher                       3688 non-null   int64  
 1   season                        3688 non-null   int64  
 2   Age                           3688 non-null   float64
 3   Throws                        3688 non-null   int64  
 4   Surgery                       3688 non-null   float64
 5   BB_release_speed_weighted_avg 3059 non-null   float64
 6   FB_release_speed_weighted_avg 3688 non-null   float64
 7   OS_release_speed_weighted_avg 3562 non-null   float64
 8   OT_release_speed_weighted_avg 1610 non-null   float64
 9   SB_release_speed_weighted_avg 2793 non-null   float64
 10  BB_release_pos_x_weighted_avg 3059 non-null   float64
 11  FB_release_pos_x_weighted_avg 3688 non-null   float64
 12  OS_release_pos_x_weighted_avg 3562 non-null   float64
 13  OT_release_pos_x_weighted_avg 1610 non-null   float64
 14  SB_release_pos_x_weighted_avg 2793 non-null   float64
 15  BB_release_pos_y_weighted_avg 3059 non-null   float64
 16  FB_release_pos_y_weighted_avg 3688 non-null   float64
 17  OS_release_pos_y_weighted_avg 3562 non-null   float64
 18  OT_release_pos_y_weighted_avg 1610 non-null   float64
 19  SB_release_pos_y_weighted_avg 2793 non-null   float64
 20  BB_release_pos_z_weighted_avg 3059 non-null   float64
 21  FB_release_pos_z_weighted_avg 3688 non-null   float64
 22  OS_release_pos_z_weighted_avg 3562 non-null   float64
 23  OT_release_pos_z_weighted_avg 1610 non-null   float64
 24  SB_release_pos_z_weighted_avg 2793 non-null   float64
 25  BB_vx0_weighted_avg           3059 non-null   float64
 26  FB_vx0_weighted_avg           3688 non-null   float64
 27  OS_vx0_weighted_avg           3562 non-null   float64
 28  OT_vx0_weighted_avg           1610 non-null   float64
 29  SB_vx0_weighted_avg           2793 non-null   float64
 30  BB_vy0_weighted_avg           3059 non-null   float64
 31  FB_vy0_weighted_avg           3688 non-null   float64
 32  OS_vy0_weighted_avg           3562 non-null   float64
 33  OT_vy0_weighted_avg           1610 non-null   float64
 34  SB_vy0_weighted_avg           2793 non-null   float64
 35  BB_vz0_weighted_avg           3059 non-null   float64
 36  FB_vz0_weighted_avg           3688 non-null   float64
 37  OS_vz0_weighted_avg           3562 non-null   float64
 38  OT_vz0_weighted_avg           1610 non-null   float64
 39  SB_vz0_weighted_avg           2793 non-null   float64
dtypes: float64(37), int64(3)
memory usage: 1.1 MB
```

This condensed DF has 40 columns compared to before where I had 130 columns.

In [74]:

```
cond_pivoted_df.fillna(0.0, inplace=True)
```

In [75]:

```
cond_pivoted_df.to_csv('data/cond_pivoted_df.csv')
```

In [76]:

```
cond_groovy_df = cond_pivoted_df
```

In [77]:

```
cond_groovy_df.drop(columns=['pitcher'], inplace=True)
```

In [78]:

```
y = cond_groovy_df['Surgery']
X = cond_groovy_df.drop('Surgery', axis=1)
```

In [79]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.
```

In [80]:

```python
logreg_pipeline = Pipeline([
    ('scale', StandardScaler()),
    ('logreg', LogisticRegression(solver='liblinear'))
])

# Define the parameter grid to search over
param_grid = {
    'logreg__C': [0.001, 0.01, 0.1, 1, 10, 100],  # Regularization str
    'logreg__penalty': ['l1', 'l2']  # Norm used in the penalization
}

# Initialize GridSearchCV with the pipeline, parameter grid, and desir
grid_search = GridSearchCV(logreg_pipeline, param_grid, cv=5, scoring=

# Assuming X_train and y_train are already defined
grid_search.fit(X_train, y_train)

# Best parameters found
print("Best parameters: ", grid_search.best_params_)

# Best cross-validation score
print("Best cross-validation score: {:.2f}".format(grid_search.best_sc

# Test set score using the best parameters
print("Test set score: {:.2f}".format(grid_search.score(X_test, y_test
```

```
C:\Users\johns\anaconda3\Lib\site-packages\sklearn\svm\_base.py:1237: Con
vergenceWarning: Liblinear failed to converge, increase the number of ite
rations.
  warnings.warn(
C:\Users\johns\anaconda3\Lib\site-packages\sklearn\svm\_base.py:1237: Con
vergenceWarning: Liblinear failed to converge, increase the number of ite
rations.
  warnings.warn(
C:\Users\johns\anaconda3\Lib\site-packages\sklearn\svm\_base.py:1237: Con
vergenceWarning: Liblinear failed to converge, increase the number of ite
rations.
  warnings.warn(
C:\Users\johns\anaconda3\Lib\site-packages\sklearn\svm\_base.py:1237: Con
vergenceWarning: Liblinear failed to converge, increase the number of ite
rations.
  warnings.warn(
C:\Users\johns\anaconda3\Lib\site-packages\sklearn\svm\_base.py:1237: Con
vergenceWarning: Liblinear failed to converge, increase the number of ite
rations.
  warnings.warn(

Best parameters:  {'logreg__C': 1, 'logreg__penalty': 'l1'}
Best cross-validation score: 0.75
Test set score: 0.75
```

In [81]:

```
logreg_pipeline = Pipeline([
    ('scale', StandardScaler()),
    ('logreg', LogisticRegression(penalty='l1', C=1.0, solver='libline
])
```

In [82]:

```
logreg_pipeline.fit(X_train, y_train)
```

Out[82]:

```
Pipeline(steps=[('scale', StandardScaler()),
                ('logreg',
                 LogisticRegression(penalty='l1', solver='liblinear'))])
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [83]:

```
logreg_pipeline.score(X_test, y_test)
```

Out[83]:

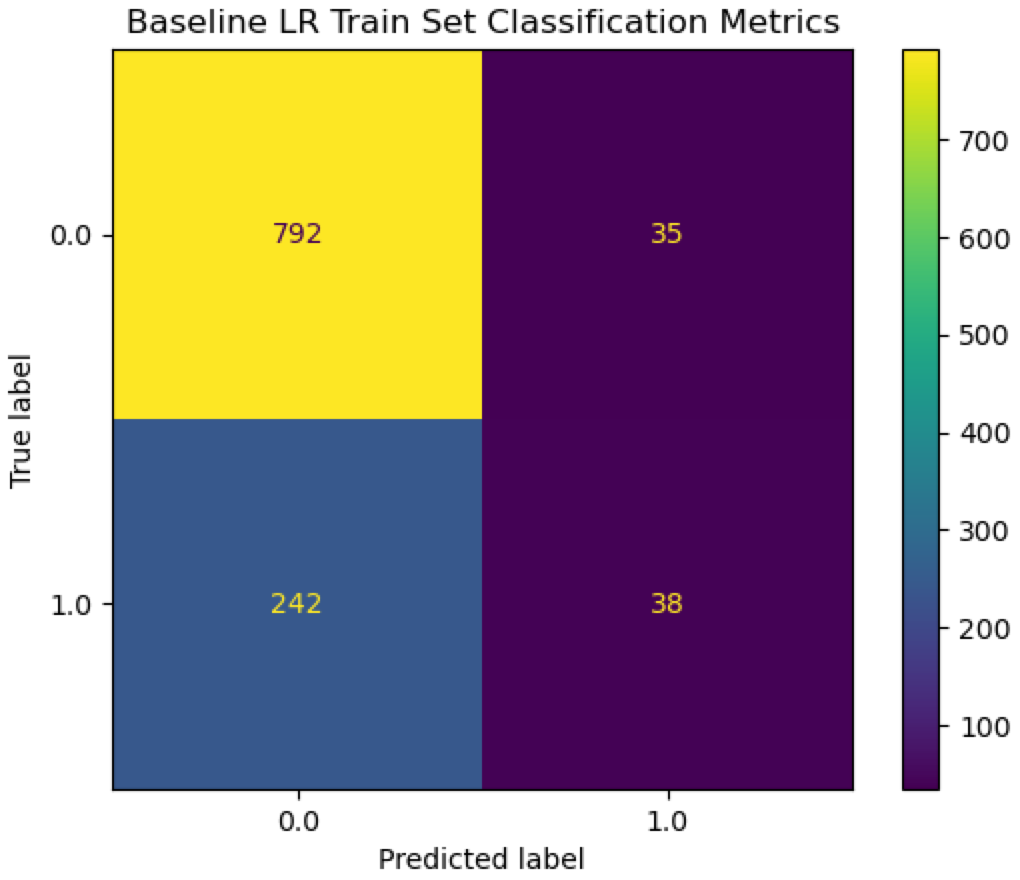
```
0.7497741644083108
```

In [84]:

```
y_pred = logreg_pipeline.predict(X_test)
```

In [85]:

```
ConfusionMatrixDisplay.from_predictions(y_test, y_pred)
plt.title('Baseline LR Train Set Classification Metrics')
plt.show()
print(classification_report(y_test, y_pred))
```



```
              precision    recall  f1-score   support

         0.0       0.77      0.96      0.85       827
         1.0       0.52      0.14      0.22       280

    accuracy                           0.75      1107
   macro avg       0.64      0.55      0.53      1107
weighted avg       0.70      0.75      0.69      1107
```

Recall score was even worse for this. Will try with SMOTE on google colab

In [31]:

```python
def pivot_metrics(df, index_cols, pivot_col, value_cols):
    """
    Pivot the DataFrame for the specified pivot column.
    :param df: DataFrame to pivot.
    :param index_cols: List of columns to use as the index.
    :param pivot_col: Column to pivot on.
    :param value_cols: Columns whose values are to be spread across piv
    :return: Pivoted DataFrame.
    """
    pivoted_dfs = []
    for value_col in value_cols:
        # Pivot each metric column separately and rename to include the
        pivoted_df = df.pivot_table(index=index_cols, columns=pivot_co
        pivoted_df.columns = [f"{col}_{value_col}" if col not in index_
        pivoted_dfs.append(pivoted_df)

    # Merge all the pivoted metric DataFrames on the index columns
    from functools import reduce
    final_df = reduce(lambda left, right: pd.merge(left, right, on=ind
    return final_df

# Define the base columns and the metrics you want to pivot
index_cols = ['pitcher', 'season', 'Age', 'Throws', 'Surgery']
pivot_col = 'pitch_type'
value_cols = ['release_speed_weighted_avg', 'release_pos_x_weighted_av

# Pivot the DataFrame
pivoted_df = pivot_metrics(funky_df, index_cols, pivot_col, value_cols

pivoted_df.head()
```

Out[31]:

	pitcher	season	Age	Throws	Surgery	AB_release_speed_weighted_avg	CH_release_spe
0	110683	2008	37.0	1	0.0	NaN	
1	110683	2009	38.0	1	0.0	NaN	
2	110683	2010	39.0	1	0.0	NaN	
3	110683	2011	40.0	1	0.0	NaN	
4	110683	2012	41.0	1	0.0	NaN	

5 rows × 131 columns

In [36]:

```
pivoted_df
```

Out[36]:

	pitcher	season	Age	Throws	Surgery	AB_release_speed_weighted_avg	CH_release_
0	110683	2008	37.0	1	0.0	0.0	
1	110683	2009	38.0	1	0.0	0.0	
2	110683	2010	39.0	1	0.0	0.0	
3	110683	2011	40.0	1	0.0	0.0	
4	110683	2012	41.0	1	0.0	0.0	
...	...	...	...	...	...	...	
3683	672578	2022	25.0	1	0.0	0.0	
3684	672578	2023	26.0	1	0.0	0.0	
3685	680686	2021	23.0	1	0.0	0.0	
3686	680686	2022	24.0	1	0.0	0.0	
3687	680686	2023	25.0	1	0.0	0.0	

3688 rows × 131 columns

In [35]:

```
pivoted_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3688 entries, 0 to 3687
Columns: 131 entries, pitcher to SV_vz0_weighted_avg
dtypes: float64(128), int64(3)
memory usage: 3.7 MB
```

In [34]:

```
pivoted_df.fillna(0.0, inplace=True)
```

In [54]:

```
pivoted_df.to_csv('data/pivoted_df.csv')
```

In [37]:

```
pivoted_df.columns
```

Out[37]:

```
Index(['pitcher', 'season', 'Age', 'Throws', 'Surgery',
       'AB_release_speed_weighted_avg', 'CH_release_speed_weighted_avg',
       'CS_release_speed_weighted_avg', 'CU_release_speed_weighted_avg',
       'EP_release_speed_weighted_avg',
       ...
       'FS_vz0_weighted_avg', 'IN_vz0_weighted_avg', 'KC_vz0_weighted_av
g',
       'KN_vz0_weighted_avg', 'PO_vz0_weighted_avg', 'SC_vz0_weighted_av
g',
       'SI_vz0_weighted_avg', 'SL_vz0_weighted_avg', 'ST_vz0_weighted_av
g',
       'SV_vz0_weighted_avg'],
      dtype='object', length=131)
```

In [82]:
```
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)
```

In [91]:
```
pd.reset_option('display.max_columns')
pd.reset_option('display.max_rows')
```

In [38]:
```
groovy_df = pivoted_df
```

Drop 'pitcher' column for groovy_df. Only used as ID, should not be necessary.

In [40]:
```
groovy_df.drop(columns=['pitcher'], inplace=True)
```

In [41]:
```
groovy_df
```

Out[41]:

	season	Age	Throws	Surgery	AB_release_speed_weighted_avg	CH_release_speed_w
0	2008	37.0	1	0.0	0.0	
1	2009	38.0	1	0.0	0.0	
2	2010	39.0	1	0.0	0.0	
3	2011	40.0	1	0.0	0.0	
4	2012	41.0	1	0.0	0.0	
...	...	...	...	...	...	
3683	2022	25.0	1	0.0	0.0	
3684	2023	26.0	1	0.0	0.0	
3685	2021	23.0	1	0.0	0.0	
3686	2022	24.0	1	0.0	0.0	
3687	2023	25.0	1	0.0	0.0	

3688 rows × 130 columns

In [42]:
```
groovy_df['Surgery'].value_counts()
```

Out[42]:
```
Surgery
0.0    2772
1.0     916
Name: count, dtype: int64
```

In [43]:
```
groovy_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3688 entries, 0 to 3687
Columns: 130 entries, season to SV_vz0_weighted_avg
dtypes: float64(128), int64(2)
memory usage: 3.7 MB
```

In [101]:

```
"""
# Reshape your data as a 2D array of 'pitch_type' column values
pitch_type_array = groovy_df['pitch_type'].values.reshape(-1, 1)

# Fit and transform the 'pitch_type' column to one-hot encoded format
pitch_type_ohe = ohe.fit_transform(pitch_type_array)

# Convert the one-hot encoded result back to a DataFrame
pitch_type_df = pd.DataFrame(pitch_type_ohe, columns=ohe.get_feature_na

# Concatenate the new one-hot encoded DataFrame with the original Data
fancy_df = pd.concat([fancy_df.drop('pitch_type', axis=1).reset_index(

fancy_df.head()
"""
```

Out[101]:

```
"\n# Reshape your data as a 2D array of 'pitch_type' column values\npitch
_type_array = groovy_df['pitch_type'].values.reshape(-1, 1)\n\n# Fit and
transform the 'pitch_type' column to one-hot encoded format\npitch_type_o
he = ohe.fit_transform(pitch_type_array)\n\n# Convert the one-hot encoded
result back to a DataFrame\npitch_type_df = pd.DataFrame(pitch_type_ohe,
columns=ohe.get_feature_names_out(['pitch_type']))\n\n# Concatenate the n
ew one-hot encoded DataFrame with the original DataFrame (excluding the o
riginal 'pitch_type' column)\nfancy_df = pd.concat([fancy_df.drop('pitch_
type', axis=1).reset_index(drop=True), pitch_type_df], axis=1)\n\nfancy_d
f.head()\n"
```

In [44]:

```
y = groovy_df['Surgery']
X = groovy_df.drop('Surgery', axis=1)
```

In [45]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.
```

In [55]:

```python
logreg_pipeline = Pipeline([
    ('scale', StandardScaler()),
    ('logreg', LogisticRegression(solver='liblinear', max_iter=10000))
])

# Define the parameter grid to search over
param_grid = {
    'logreg__C': [0.001, 0.01, 0.1, 1, 10, 100],  # Regularization str
    'logreg__penalty': ['l1', 'l2']  # Norm used in the penalization
}

# Initialize GridSearchCV with the pipeline, parameter grid, and desir
grid_search = GridSearchCV(logreg_pipeline, param_grid, cv=5, scoring=

# Assuming X_train and y_train are already defined
grid_search.fit(X_train, y_train)

# Best parameters found
print("Best parameters: ", grid_search.best_params_)

# Best cross-validation score
print("Best cross-validation score: {:.2f}".format(grid_search.best_sc

# Test set score using the best parameters
print("Test set score: {:.2f}".format(grid_search.score(X_test, y_test
```

```
Best parameters:  {'logreg__C': 10, 'logreg__penalty': 'l1'}
Best cross-validation score: 0.76
Test set score: 0.77
```

In [48]:

```python
logreg_pipeline = Pipeline([
    ('scale', StandardScaler()),
    ('logreg', LogisticRegression(penalty='l1', C=10.0, solver='liblin
])
```

In [49]:

```python
logreg_pipeline.fit(X_train, y_train)
```

Out[49]:

```
Pipeline(steps=[('scale', StandardScaler()),
                ('logreg',
                 LogisticRegression(C=10.0, penalty='l1', solver='libline
ar'))])
```

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [50]:

```python
logreg_pipeline.score(X_test, y_test)
```

Out[50]:

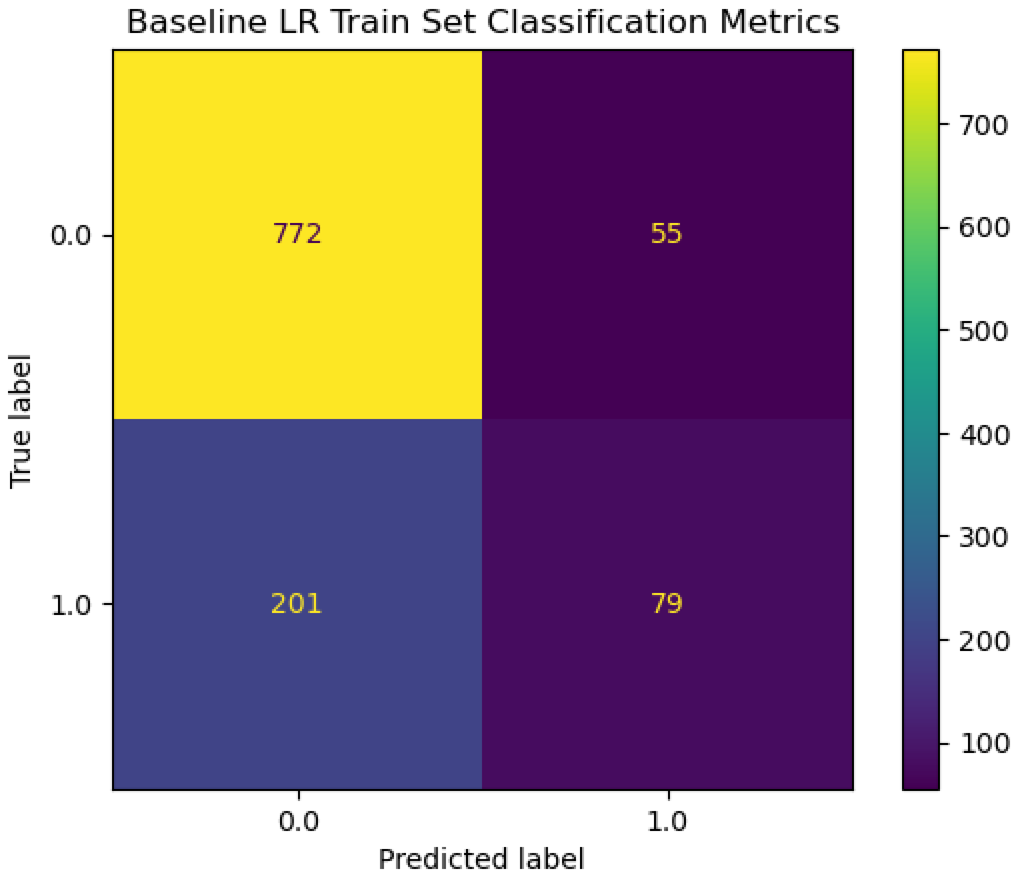
```
0.7687443541102078
```

In [51]:

```python
y_pred = logreg_pipeline.predict(X_test)
```

In [52]:

```
ConfusionMatrixDisplay.from_predictions(y_test, y_pred)
plt.title('Baseline LR Train Set Classification Metrics')
plt.show()
print(classification_report(y_test, y_pred))
```



```
              precision    recall  f1-score   support

         0.0       0.79      0.93      0.86       827
         1.0       0.59      0.28      0.38       280

    accuracy                           0.77      1107
   macro avg       0.69      0.61      0.62      1107
weighted avg       0.74      0.77      0.74      1107
```

Want more false positives (think needs TJ but doesn't need TJ) than false negatives...

In [ ]:

```

```