Project Title "Drug safety and pharmacovigilance"

1. OBJECTIVE

Exploration of Patient Data:

Analyze patient demographics (Age, Sex) and health indicators (Blood Pressure, Cholesterol, Na to Potassium Ratio) to derive meaningful insights.

Understand patterns and correlations in the data to guide decisions in drug safety and efficacy.

Prediction of Drug Type:

Use health indicators to predict the most suitable drug type for patients.

Apply machine learning techniques for prediction and accuracy evaluation.

Beginner-Friendly Approach:

Provide a guided framework for beginners in machine learning and data analytics.

Emphasize simplicity and clarity, making advanced techniques optional.

Insight Generation:

Focus on understanding the relationship between health indicators and drug outcomes.

Utilize statistical and visualization techniques to interpret data trends.

Pharmacovigilance Applications:

Demonstrate real-world relevance by linking analysis to drug safety and adverse effect prevention.

Highlight the importance of data-driven decision-making in healthcare.

2.Data Collection and Preparation

2.1 Data Collection

In [7]:
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
```

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
import matplotlib.pyplot as plt
import seaborn as sns
```

In [9]:
```
df = pd.read_csv(r"C:\Users\chira\Downloads\Drug safety and pharmacovigilance.csv")
```

In [10]:
```
df.head()
```

Out[10]:

	Age	Sex	BP	Cholesterol	Na_to_K	Drug
0	23	F	HIGH	HIGH	25.355	DrugY
1	47	M	LOW	HIGH	13.093	drugC
2	47	M	LOW	HIGH	10.114	drugC
3	28	F	NORMAL	HIGH	7.798	drugX
4	61	F	LOW	HIGH	18.043	DrugY

In [11]:
```
df.tail()
```

Out[11]:

	Age	Sex	BP	Cholesterol	Na_to_K	Drug
195	56	F	LOW	HIGH	11.567	drugC
196	16	M	LOW	HIGH	12.006	drugC
197	52	M	NORMAL	HIGH	9.894	drugX
198	23	M	NORMAL	NORMAL	14.020	drugX
199	40	F	LOW	NORMAL	11.349	drugX

In [12]:
```
df.shape
```

Out[12]:
```
(200, 6)
```

Data pre-processing and EDA

In [13]:
```
df.isnull().sum()
```

Out[13]:
```
Age            0
Sex            0
BP             0
Cholesterol    0
Na_to_K        0
Drug           0
dtype: int64
```

In [14]:
```
df.dropna(inplace=True)
```

In [15]:
```
df.isnull().sum()
```

Out[15]:
```
Age            0
Sex            0
BP             0
Cholesterol    0
Na_to_K        0
Drug           0
dtype: int64
```

In [16]:
```
df.info()
```

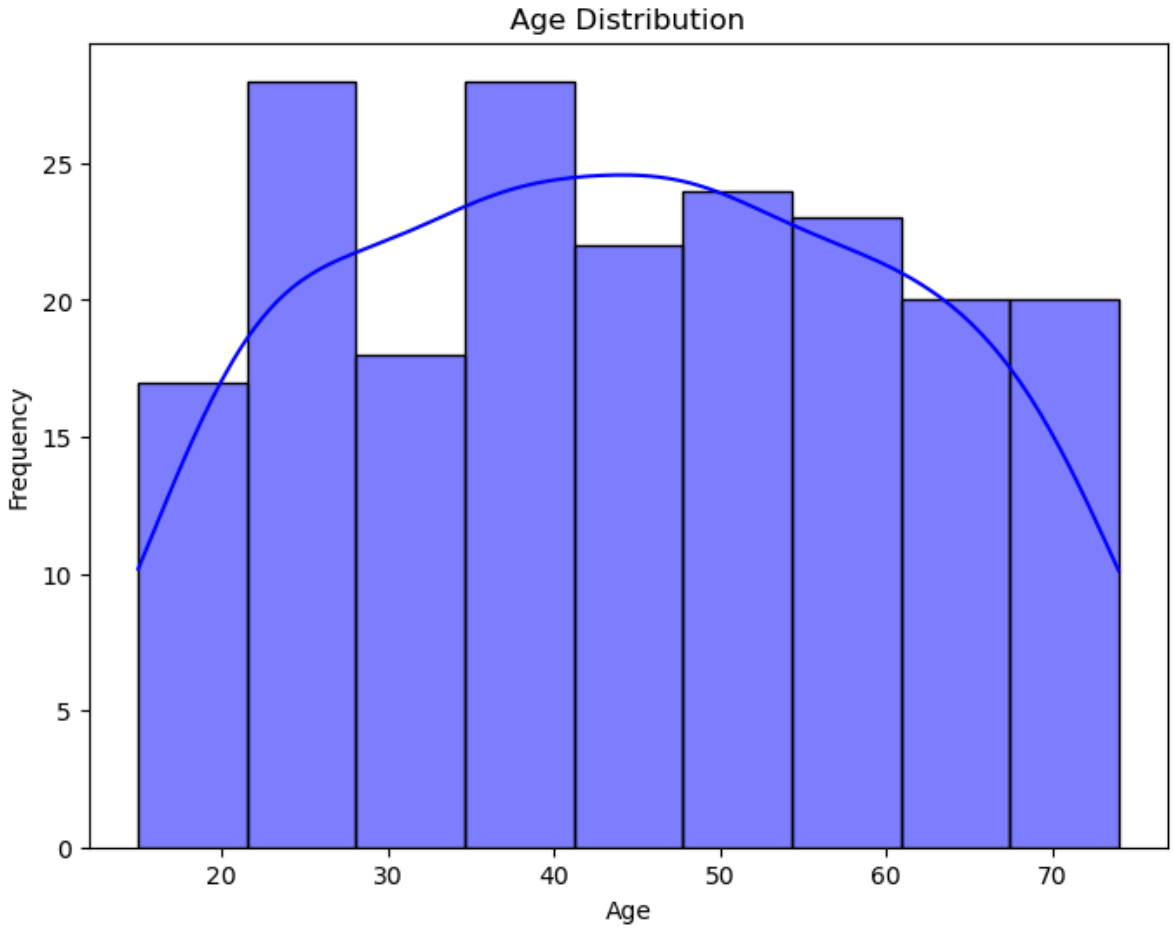
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 6 columns):
 #   Column       Non-Null Count  Dtype  
---  ------       --------------  -----  
 0   Age          200 non-null    int64  
 1   Sex          200 non-null    object 
 2   BP           200 non-null    object 
 3   Cholesterol  200 non-null    object 
 4   Na_to_K      200 non-null    float64
 5   Drug         200 non-null    object 
dtypes: float64(1), int64(1), object(4)
memory usage: 9.5+ KB
```

In [18]:
```
print(df.describe())
```

```
              Age     Na_to_K
count  200.000000  200.000000
mean    44.315000   16.084485
std     16.544315    7.223956
min     15.000000    6.269000
25%     31.000000   10.445500
50%     45.000000   13.936500
75%     58.000000   19.380000
max     74.000000   38.247000
```

In [19]:
```
# # Step 2: Data Visualization
# Distribution of Age
```

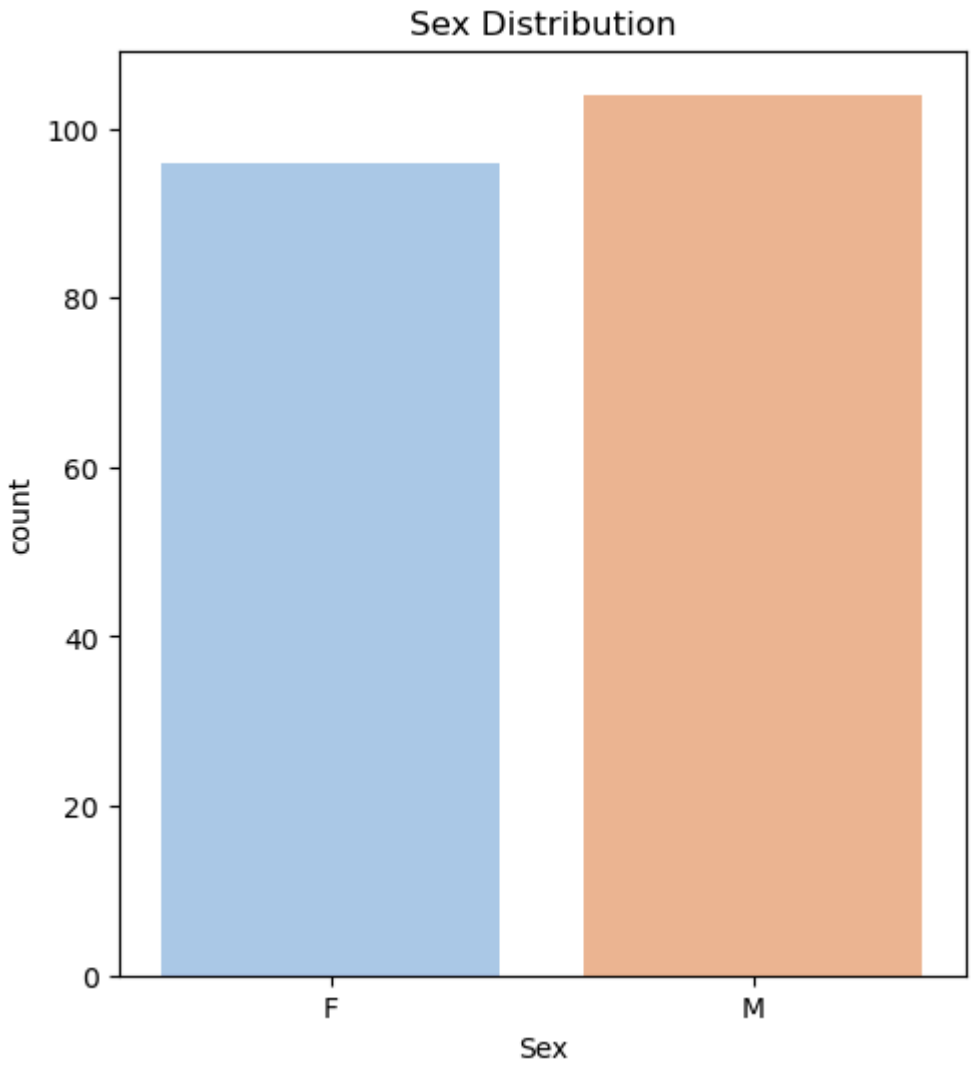
In [21]:
```
plt.figure(figsize=(8, 6))
sns.histplot(df['Age'], kde=True, color='blue')
plt.title('Age Distribution')
plt.xlabel('Age')
plt.ylabel('Frequency')
plt.show()
```



In [25]:
```
# Count plot for categorical variables
plt.figure(figsize=(12, 6))
plt.subplot(1, 2, 1)
sns.countplot(x='Sex', data=df, palette='pastel')
plt.title('Sex Distribution')
```

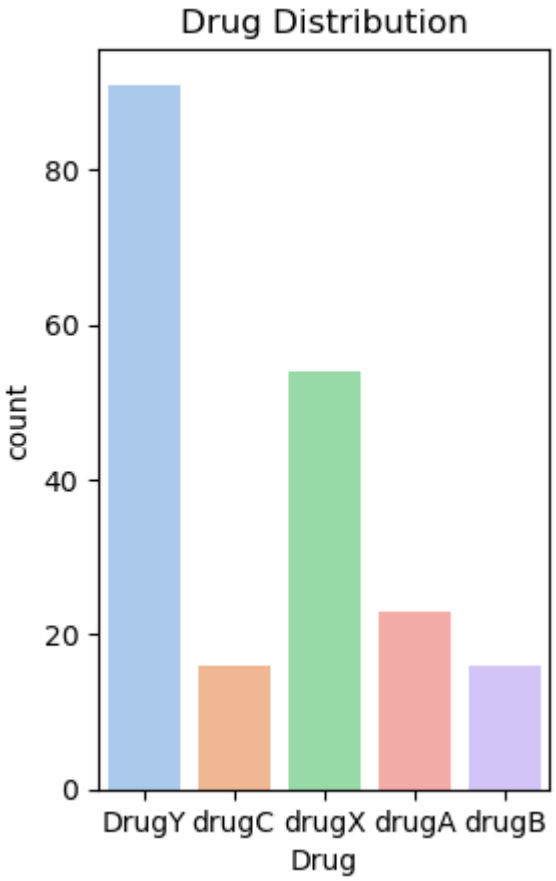
```
C:\Users\chira\AppData\Local\Temp\ipykernel_7980\141738159.py:4: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.
14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effect.

  sns.countplot(x='Sex', data=df, palette='pastel')
```

Out[25]:
```
Text(0.5, 1.0, 'Sex Distribution')
```

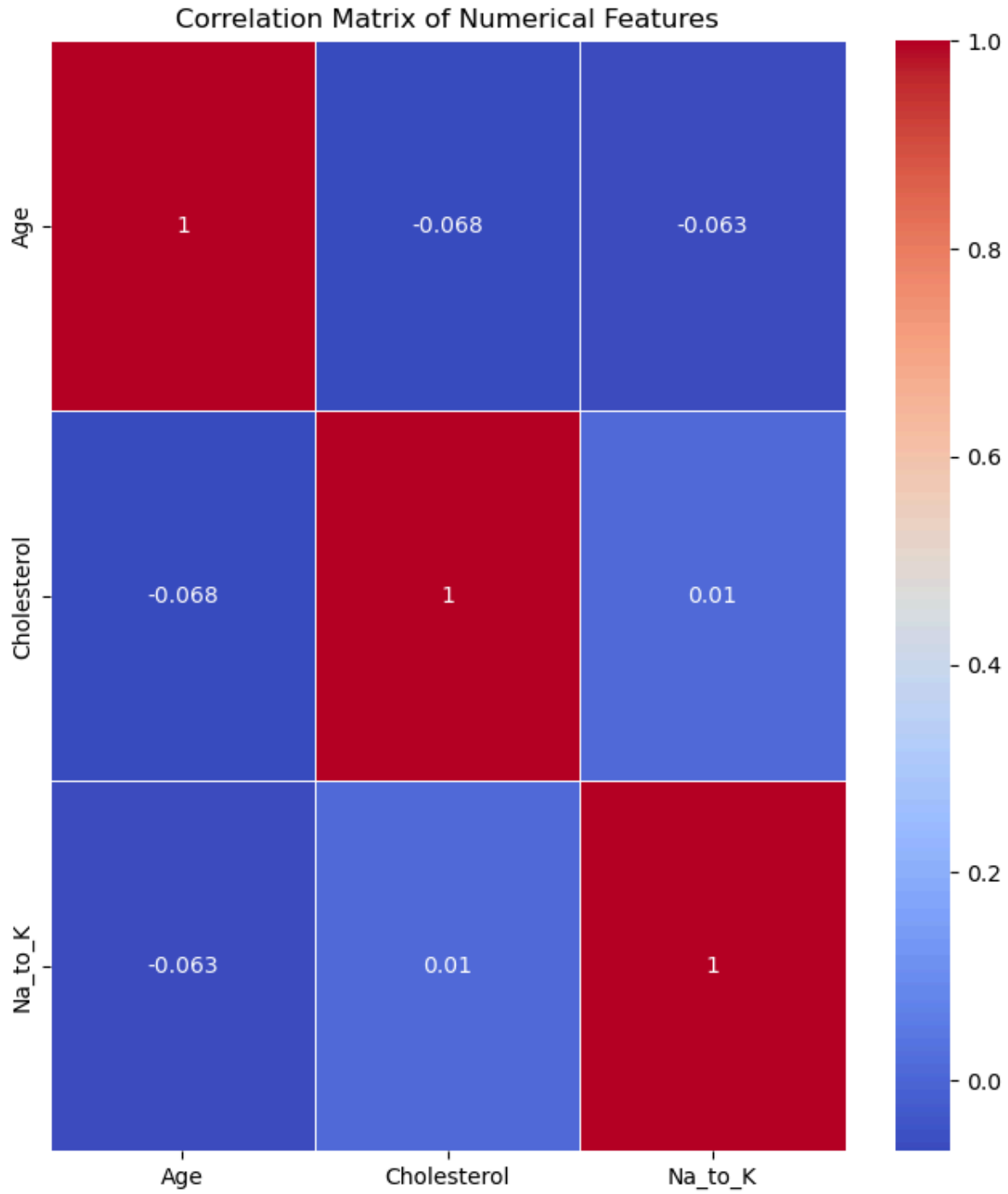


In [26]:
```
plt.subplot(1, 2, 2)
sns.countplot(x='Drug', data=df, palette='pastel')
plt.title('Drug Distribution')
plt.show()
```

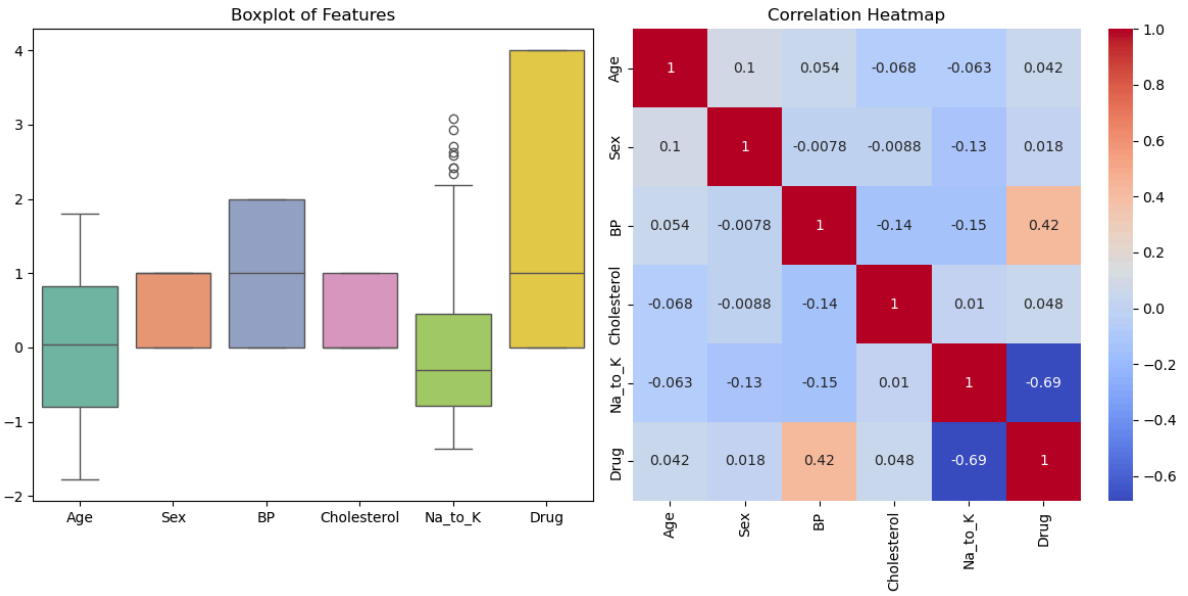
```
C:\Users\chira\AppData\Local\Temp\ipykernel_7980\3461135436.py:2: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.
14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effect.

  sns.countplot(x='Drug', data=df, palette='pastel')
```



In [55]:
```
# Calculate the correlation matrix
corr_matrix = df[['Age', 'Cholesterol', 'Na_to_K']].corr()

# Create a heatmap
plt.figure(figsize=(8, 9))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', linewidths=0.5)

# Set plot title
plt.title('Correlation Matrix of Numerical Features')

# Show the plot
plt.show()
```

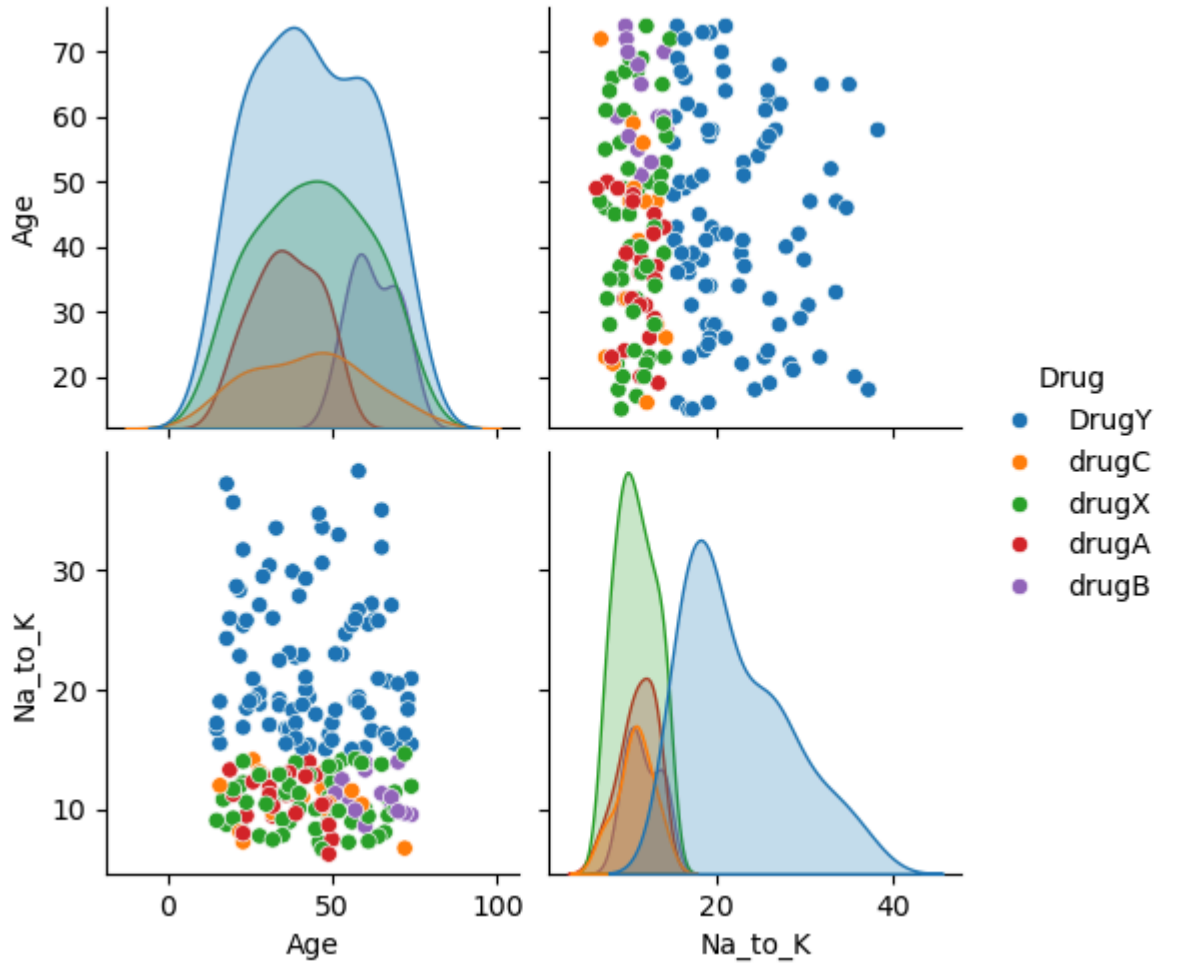


In [59]:
```
# Create subplots
fig, axes = plt.subplots(1, 2, figsize=(12, 6))

# Boxplot
sns.boxplot(data=df, orient='v', palette='Set2', ax=axes[0])
axes[0].set_title('Boxplot of Features')

# Heatmap
corr_matrix = df.corr()
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', ax=axes[1])
axes[1].set_title('Correlation Heatmap')

# Adjust layout and display
plt.tight_layout()
plt.show()
```



In [28]:
```
# Pairplot to visualize relationships
sns.pairplot(df, hue='Drug', diag_kind='kde')
plt.show()
```

```
C:\Users\chira\anaconda3\Lib\site-packages\seaborn\axisgrid.py:123: UserWarning: T
he figure layout has changed to tight
  self._figure.tight_layout(*args, **kwargs)
```



In [30]:
```
from sklearn.preprocessing import LabelEncoder, StandardScaler
```

In [34]:
```
# Step 3: Data Preprocessing
# Encode categorical variables
label_encoders = {}
```

```
for column in ['Sex', 'BP', 'Cholesterol', 'Drug']:
    le = LabelEncoder()
    df[column] = le.fit_transform(df[column])
    label_encoders[column] = le
```

In [35]:
```
# Feature scaling
scaler = StandardScaler()
df[['Age', 'Na_to_K']] = scaler.fit_transform(df[['Age', 'Na_to_K']])
```

In [36]:
```
# Splitting data into features and target
X = df.drop('Drug', axis=1)
y = df['Drug']
```

In [38]:
```
# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_sta
```

In [40]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
```

In [41]:
```
# Step 4: Model Building
# Using Random Forest Classifier
model = RandomForestClassifier(random_state=42)
model.fit(X_train, y_train)
```

Out[41]:
```
RandomForestClassifier
RandomForestClassifier(random_state=42)
```

In [42]:
```
# Predictions
y_pred = model.predict(X_test)
```

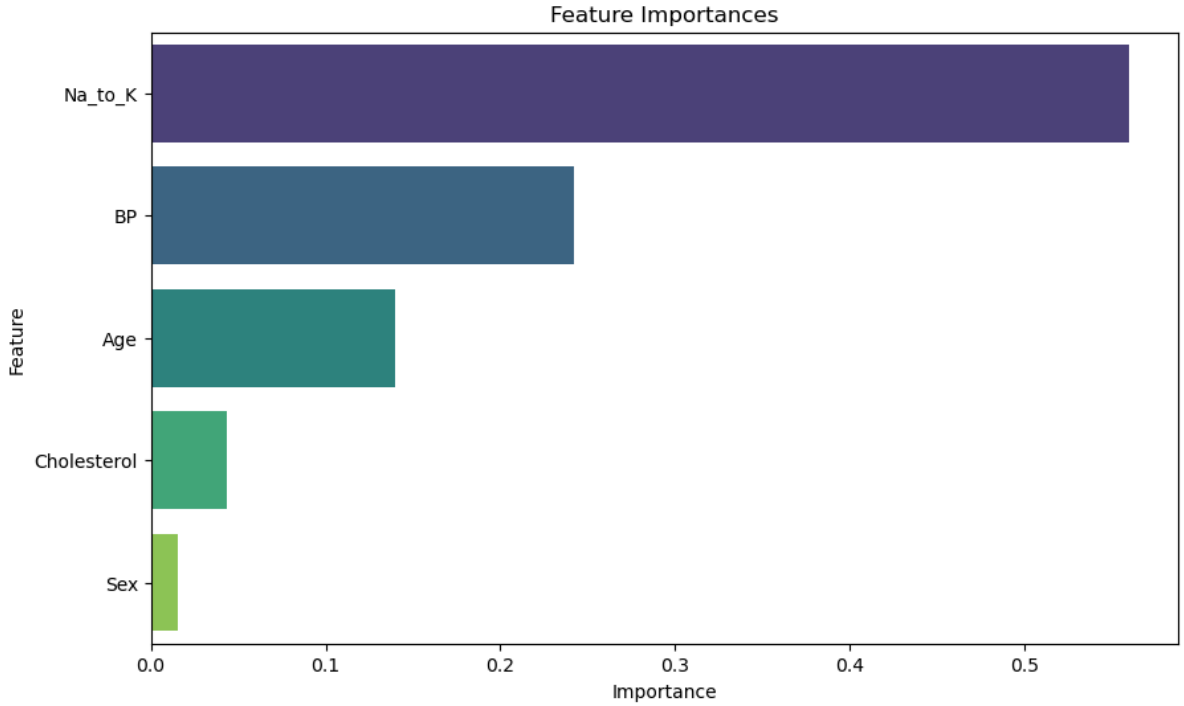
In [43]:
```
# Step 5: Evaluation
print("Classification Report:")
print(classification_report(y_test, y_pred))

print("Confusion Matrix:")
print(confusion_matrix(y_test, y_pred))

accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy: {accuracy * 100:.2f}%")
```

```
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        15
           1       1.00      1.00      1.00         6
           2       1.00      1.00      1.00         3
           3       1.00      1.00      1.00         5
           4       1.00      1.00      1.00        11

    accuracy                           1.00        40
   macro avg       1.00      1.00      1.00        40
weighted avg       1.00      1.00      1.00        40

Confusion Matrix:
[[15  0  0  0  0]
 [ 0  6  0  0  0]
 [ 0  0  3  0  0]
 [ 0  0  0  5  0]
 [ 0  0  0  0 11]]
Accuracy: 100.00%
```

In [44]:
```
# Feature Importance
feature_importances = pd.DataFrame({'Feature': X.columns, 'Importance': model.featu
feature_importances = feature_importances.sort_values(by='Importance', ascending=Fa
```

In [45]:
```
plt.figure(figsize=(10, 6))
sns.barplot(x='Importance', y='Feature', data=feature_importances, palette='viridis
plt.title('Feature Importances')
plt.xlabel('Importance')
plt.ylabel('Feature')
plt.show()
```

```
C:\Users\chira\AppData\Local\Temp\ipykernel_7980\545838370.py:2: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.
14.0. Assign the `y` variable to `hue` and set `legend=False` for the same effect.

  sns.barplot(x='Importance', y='Feature', data=feature_importances, palette='viri
dis')
```



In [61]:
```
for i in df.iterrows():
 print(i)
```

```
(0, Age           -1.291591
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        1.286522
Drug           0.000000
Name: 0, dtype: float64)
(1, Age            0.162699
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.415145
Drug           3.000000
Name: 1, dtype: float64)
(2, Age            0.162699
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.828558
Drug           3.000000
Name: 2, dtype: float64)
(3, Age           -0.988614
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -1.149963
Drug           4.000000
Name: 3, dtype: float64)
(4, Age            1.011034
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.271794
Drug           0.000000
Name: 4, dtype: float64)
(5, Age           -1.352186
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -1.037693
Drug           4.000000
Name: 5, dtype: float64)
(6, Age            0.283889
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.026439
Drug           0.000000
Name: 6, dtype: float64)
(7, Age           -0.200874
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.700468
Drug           3.000000
Name: 7, dtype: float64)
(8, Age            0.950439
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.126770
Drug           0.000000
Name: 8, dtype: float64)
(9, Age           -0.079683
```

```
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.455672
Drug           0.000000
Name: 9, dtype: float64)
(10, Age            0.162699
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.599162
Drug           3.000000
Name: 10, dtype: float64)
(11, Age           -0.625042
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.432219
Drug           0.000000
Name: 11, dtype: float64)
(12, Age           -0.079683
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.098320
Drug           0.000000
Name: 12, dtype: float64)
(13, Age            1.798775
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.674105
Drug           0.000000
Name: 13, dtype: float64)
(14, Age            0.344485
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.469268
Drug           4.000000
Name: 14, dtype: float64)
(15, Age           -1.715759
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.078892
Drug           0.000000
Name: 15, dtype: float64)
(16, Age            1.495798
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.642460
Drug           4.000000
Name: 16, dtype: float64)
(17, Age           -0.079683
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.293162
Drug           1.000000
Name: 17, dtype: float64)
(18, Age           -1.291591
Sex            1.000000
```

```
BP             1.000000
Cholesterol    0.000000
Na_to_K       -1.219351
Drug           3.000000
Name: 18, dtype: float64)
(19, Age           -0.746232
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        1.372424
Drug           0.000000
Name: 19, dtype: float64)
(20, Age            0.768653
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.422366
Drug           0.000000
Name: 20, dtype: float64)
(21, Age            1.132225
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        1.364514
Drug           0.000000
Name: 21, dtype: float64)
(22, Age            0.162699
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        2.009960
Drug           0.000000
Name: 22, dtype: float64)
(23, Age            0.223294
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.145504
Drug           0.000000
Name: 23, dtype: float64)
(24, Age           -0.685637
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        2.414907
Drug           0.000000
Name: 24, dtype: float64)
(25, Age           -0.988614
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.378096
Drug           0.000000
Name: 25, dtype: float64)
(26, Age           -0.806828
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        1.981927
Drug           0.000000
Name: 26, dtype: float64)
(27, Age            0.283889
Sex            0.000000
BP             2.000000
```

```
Cholesterol    1.000000
Na_to_K       -0.930281
Drug           4.000000
Name: 27, dtype: float64)
(28, Age           -0.322065
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.917656
Drug           0.000000
Name: 28, dtype: float64)
(29, Age            0.041508
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.259027
Drug           0.000000
Name: 29, dtype: float64)
(30, Age           -1.594568
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.017848
Drug           4.000000
Name: 30, dtype: float64)
(31, Age            1.798775
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.904468
Drug           2.000000
Name: 31, dtype: float64)
(32, Age            0.283889
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.703660
Drug           4.000000
Name: 32, dtype: float64)
(33, Age            1.253416
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        2.191478
Drug           0.000000
Name: 33, dtype: float64)
(34, Age            0.526271
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.270819
Drug           4.000000
Name: 34, dtype: float64)
(35, Age            0.102103
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.221155
Drug           4.000000
Name: 35, dtype: float64)
(36, Age           -0.746232
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
```

```
Na_to_K       -0.921399
Drug           1.000000
Name: 36, dtype: float64)
(37, Age           -0.322065
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.297880
Drug           4.000000
Name: 37, dtype: float64)
(38, Age           -0.322065
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.884762
Drug           4.000000
Name: 38, dtype: float64)
(39, Age           -1.776354
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.971497
Drug           4.000000
Name: 39, dtype: float64)
(40, Age            1.738179
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.435272
Drug           0.000000
Name: 40, dtype: float64)
(41, Age            0.829248
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.256108
Drug           2.000000
Name: 41, dtype: float64)
(42, Age            0.344485
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.040867
Drug           0.000000
Name: 42, dtype: float64)
(43, Age           -1.291591
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.530746
Drug           4.000000
Name: 43, dtype: float64)
(44, Age            0.344485
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.525888
Drug           4.000000
Name: 44, dtype: float64)
(45, Age            1.314011
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.107081
```

```
Drug           4.000000
Name: 45, dtype: float64)
(46, Age          -0.443255
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.415423
Drug           1.000000
Name: 46, dtype: float64)
(47, Age           1.435202
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.803995
Drug           3.000000
Name: 47, dtype: float64)
(48, Age          -1.291591
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        2.165111
Drug           0.000000
Name: 48, dtype: float64)
(49, Age          -0.988614
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.515068
Drug           0.000000
Name: 49, dtype: float64)
(50, Age           0.829248
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        0.462333
Drug           0.000000
Name: 50, dtype: float64)
(51, Age           1.374607
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.719758
Drug           4.000000
Name: 51, dtype: float64)
(52, Age           1.071630
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        1.540204
Drug           0.000000
Name: 52, dtype: float64)
(53, Age          -1.230996
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.329247
Drug           0.000000
Name: 53, dtype: float64)
(54, Age           1.435202
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.818150
Drug           2.000000
```

```
Name: 54, dtype: float64)
(55, Age           -1.109805
Sex             0.000000
BP              1.000000
Cholesterol     0.000000
Na_to_K        -0.267072
Drug            3.000000
Name: 55, dtype: float64)
(56, Age            1.253416
Sex             1.000000
BP              0.000000
Cholesterol     1.000000
Na_to_K        -0.658419
Drug            2.000000
Name: 56, dtype: float64)
(57, Age           -0.261469
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K         1.629437
Drug            0.000000
Name: 57, dtype: float64)
(58, Age            0.950439
Sex             1.000000
BP              2.000000
Cholesterol     1.000000
Na_to_K        -0.831750
Drug            4.000000
Name: 58, dtype: float64)
(59, Age           -0.625042
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K         0.363386
Drug            0.000000
Name: 59, dtype: float64)
(60, Age           -0.382660
Sex             0.000000
BP              1.000000
Cholesterol     1.000000
Na_to_K         1.913788
Drug            0.000000
Name: 60, dtype: float64)
(61, Age           -1.230996
Sex             1.000000
BP              0.000000
Cholesterol     1.000000
Na_to_K        -0.917236
Drug            1.000000
Name: 61, dtype: float64)
(62, Age            1.374607
Sex             1.000000
BP              1.000000
Cholesterol     1.000000
Na_to_K         0.639550
Drug            0.000000
Name: 62, dtype: float64)
(63, Age            0.041508
Sex             1.000000
BP              1.000000
Cholesterol     1.000000
Na_to_K        -1.070583
Drug            4.000000
Name: 63, dtype: float64)
```

```
(64, Age            0.950439
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.386003
Drug           2.000000
Name: 64, dtype: float64)
(65, Age            1.435202
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K        1.521747
Drug           0.000000
Name: 65, dtype: float64)
(66, Age           -0.928019
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.448035
Drug           1.000000
Name: 66, dtype: float64)
(67, Age           -1.655163
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.728917
Drug           4.000000
Name: 67, dtype: float64)
(68, Age            0.586866
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        1.189795
Drug           0.000000
Name: 68, dtype: float64)
(69, Age           -1.594568
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        1.136783
Drug           0.000000
Name: 69, dtype: float64)
(70, Age            1.556393
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.293855
Drug           2.000000
Name: 70, dtype: float64)
(71, Age           -0.988614
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.498276
Drug           0.000000
Name: 71, dtype: float64)
(72, Age           -1.230996
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.760419
Drug           4.000000
Name: 72, dtype: float64)
(73, Age           -0.200874
```

```
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K        0.946522
Drug           0.000000
Name: 73, dtype: float64)
(74, Age           -0.806828
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.136627
Drug           0.000000
Name: 74, dtype: float64)
(75, Age           -1.109805
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.669525
Drug           0.000000
Name: 75, dtype: float64)
(76, Age           -0.503851
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.678125
Drug           1.000000
Name: 76, dtype: float64)
(77, Age           -1.109805
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.426945
Drug           0.000000
Name: 77, dtype: float64)
(78, Age           -1.533973
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.384615
Drug           1.000000
Name: 78, dtype: float64)
(79, Age           -0.746232
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.727807
Drug           4.000000
Name: 79, dtype: float64)
(80, Age            0.950439
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.298435
Drug           2.000000
Name: 80, dtype: float64)
(81, Age            1.192821
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -1.155097
Drug           4.000000
Name: 81, dtype: float64)
(82, Age           -0.746232
Sex            0.000000
```

```
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.884346
Drug           3.000000
Name: 82, dtype: float64)
(83, Age          -0.382660
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.660362
Drug           1.000000
Name: 83, dtype: float64)
(84, Age           0.162699
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.835081
Drug           3.000000
Name: 84, dtype: float64)
(85, Age           0.889843
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.298296
Drug           2.000000
Name: 85, dtype: float64)
(86, Age           0.405080
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.345202
Drug           4.000000
Name: 86, dtype: float64)
(87, Age           1.495798
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.084165
Drug           0.000000
Name: 87, dtype: float64)
(88, Age          -0.443255
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.972334
Drug           0.000000
Name: 88, dtype: float64)
(89, Age           0.344485
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K        0.156333
Drug           0.000000
Name: 89, dtype: float64)
(90, Age           1.071630
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.070708
Drug           0.000000
Name: 90, dtype: float64)
(91, Age          -0.200874
Sex            1.000000
BP             0.000000
```

```
Cholesterol    1.000000
Na_to_K       -0.128851
Drug           0.000000
Name: 91, dtype: float64)
(92, Age           -0.928019
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        1.854809
Drug           0.000000
Name: 92, dtype: float64)
(93, Age           -0.140278
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        1.829968
Drug           0.000000
Name: 93, dtype: float64)
(94, Age            0.708057
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.148419
Drug           0.000000
Name: 94, dtype: float64)
(95, Age           -0.503851
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.646762
Drug           4.000000
Name: 95, dtype: float64)
(96, Age            0.829248
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        3.075618
Drug           0.000000
Name: 96, dtype: float64)
(97, Age            0.708057
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        1.292073
Drug           0.000000
Name: 97, dtype: float64)
(98, Age           -1.473377
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        2.713691
Drug           0.000000
Name: 98, dtype: float64)
(99, Age           -1.776354
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.088888
Drug           0.000000
Name: 99, dtype: float64)
(100, Age           -0.806828
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
```

```
Na_to_K       -0.584729
Drug           1.000000
Name: 100, dtype: float64)
(101, Age            0.041508
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.448313
Drug           1.000000
Name: 101, dtype: float64)
(102, Age           -0.988614
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.410427
Drug           3.000000
Name: 102, dtype: float64)
(103, Age            0.708057
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.987873
Drug           4.000000
Name: 103, dtype: float64)
(104, Age           -1.352186
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        1.694384
Drug           0.000000
Name: 104, dtype: float64)
(105, Age           -0.443255
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.987595
Drug           4.000000
Name: 105, dtype: float64)
(106, Age           -1.352186
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.573350
Drug           4.000000
Name: 106, dtype: float64)
(107, Age           -0.140278
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.545182
Drug           0.000000
Name: 107, dtype: float64)
(108, Age            1.677584
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.889203
Drug           2.000000
Name: 108, dtype: float64)
(109, Age           -1.291591
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.106235
```

```
Drug           0.000000
Name: 109, dtype: float64)
(110, Age            0.344485
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -1.192706
Drug           1.000000
Name: 110, dtype: float64)
(111, Age            0.162699
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.304698
Drug           4.000000
Name: 111, dtype: float64)
(112, Age           -0.564446
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.959562
Drug           4.000000
Name: 112, dtype: float64)
(113, Age            1.253416
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.321333
Drug           4.000000
Name: 113, dtype: float64)
(114, Age           -1.473377
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.944158
Drug           4.000000
Name: 114, dtype: float64)
(115, Age            0.405080
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        0.306766
Drug           0.000000
Name: 115, dtype: float64)
(116, Age            1.374607
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.911824
Drug           4.000000
Name: 116, dtype: float64)
(117, Age           -0.261469
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.830085
Drug           4.000000
Name: 117, dtype: float64)
(118, Age           -0.746232
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.803856
Drug           1.000000
```

```
Name: 118, dtype: float64)
(119, Age            1.011034
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        1.303175
Drug           0.000000
Name: 119, dtype: float64)
(120, Age           -0.988614
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        1.523690
Drug           0.000000
Name: 120, dtype: float64)
(121, Age           -1.776354
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.155639
Drug           0.000000
Name: 121, dtype: float64)
(122, Age           -0.625042
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.884211
Drug           0.000000
Name: 122, dtype: float64)
(123, Age           -0.503851
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.092774
Drug           0.000000
Name: 123, dtype: float64)
(124, Age            0.526271
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.498133
Drug           2.000000
Name: 124, dtype: float64)
(125, Age           -1.533973
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        1.371730
Drug           0.000000
Name: 125, dtype: float64)
(126, Age            1.314011
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        0.036431
Drug           0.000000
Name: 126, dtype: float64)
(127, Age           -0.564446
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.143440
Drug           4.000000
Name: 127, dtype: float64)
```

```
(128, Age            0.162699
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        2.422679
Drug           0.000000
Name: 128, dtype: float64)
(129, Age           -0.746232
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -1.194510
Drug           4.000000
Name: 129, dtype: float64)
(130, Age            1.556393
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.611240
Drug           0.000000
Name: 130, dtype: float64)
(131, Age            0.465676
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        2.336638
Drug           0.000000
Name: 131, dtype: float64)
(132, Age            0.283889
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.345064
Drug           4.000000
Name: 132, dtype: float64)
(133, Age           -1.230996
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        1.346334
Drug           0.000000
Name: 133, dtype: float64)
(134, Age           -0.140278
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        0.687150
Drug           0.000000
Name: 134, dtype: float64)
(135, Age            1.798775
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.575293
Drug           4.000000
Name: 135, dtype: float64)
(136, Age            0.647462
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.708795
Drug           2.000000
Name: 136, dtype: float64)
(137, Age           -0.564446
```

```
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.442762
Drug           1.000000
Name: 137, dtype: float64)
(138, Age            0.405080
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.658003
Drug           2.000000
Name: 138, dtype: float64)
(139, Age            1.495798
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.835358
Drug           4.000000
Name: 139, dtype: float64)
(140, Age            0.283889
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -1.362151
Drug           1.000000
Name: 140, dtype: float64)
(141, Age            1.192821
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        1.340090
Drug           0.000000
Name: 141, dtype: float64)
(142, Age            0.950439
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -1.035750
Drug           2.000000
Name: 142, dtype: float64)
(143, Age            1.798775
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.089994
Drug           0.000000
Name: 143, dtype: float64)
(144, Age           -0.322065
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.891007
Drug           1.000000
Name: 144, dtype: float64)
(145, Age            1.011034
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.921677
Drug           4.000000
Name: 145, dtype: float64)
(146, Age           -0.443255
Sex            0.000000
```

```
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.565995
Drug           4.000000
Name: 146, dtype: float64)
(147, Age           -1.109805
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.524223
Drug           1.000000
Name: 147, dtype: float64)
(148, Age            1.011034
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -1.213522
Drug           4.000000
Name: 148, dtype: float64)
(149, Age           -1.352186
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -1.100975
Drug           3.000000
Name: 149, dtype: float64)
(150, Age            0.283889
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -1.024787
Drug           1.000000
Name: 150, dtype: float64)
(151, Age            1.435202
Sex            1.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.704354
Drug           2.000000
Name: 151, dtype: float64)
(152, Age            0.647462
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -1.224485
Drug           4.000000
Name: 152, dtype: float64)
(153, Age            1.677584
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.200182
Drug           4.000000
Name: 153, dtype: float64)
(154, Age           -0.443255
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.088749
Drug           0.000000
Name: 154, dtype: float64)
(155, Age            0.283889
Sex            1.000000
BP             1.000000
```

```
Cholesterol    0.000000
Na_to_K       -0.769856
Drug           3.000000
Name: 155, dtype: float64)
(156, Age           -0.806828
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.674101
Drug           1.000000
Name: 156, dtype: float64)
(157, Age            0.526271
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.954571
Drug           0.000000
Name: 157, dtype: float64)
(158, Age            0.889843
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.782762
Drug           3.000000
Name: 158, dtype: float64)
(159, Age           -0.625042
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.438737
Drug           4.000000
Name: 159, dtype: float64)
(160, Age           -0.867423
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.782901
Drug           4.000000
Name: 160, dtype: float64)
(161, Age            0.768653
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.852011
Drug           2.000000
Name: 161, dtype: float64)
(162, Age           -0.079683
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.447619
Drug           4.000000
Name: 162, dtype: float64)
(163, Age           -1.412782
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        1.741290
Drug           0.000000
Name: 163, dtype: float64)
(164, Age           -1.715759
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
```

```
Na_to_K        0.405574
Drug           0.000000
Name: 164, dtype: float64)
(165, Age           -0.382660
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.306766
Drug           0.000000
Name: 165, dtype: float64)
(166, Age            0.829248
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        1.465543
Drug           0.000000
Name: 166, dtype: float64)
(167, Age            0.768653
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.259300
Drug           4.000000
Name: 167, dtype: float64)
(168, Age            0.405080
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.960122
Drug           0.000000
Name: 168, dtype: float64)
(169, Age           -1.473377
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K       -0.669244
Drug           1.000000
Name: 169, dtype: float64)
(170, Age           -0.988614
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.444843
Drug           4.000000
Name: 170, dtype: float64)
(171, Age            0.041508
Sex            1.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.842019
Drug           4.000000
Name: 171, dtype: float64)
(172, Age           -0.322065
Sex            0.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K        0.158276
Drug           0.000000
Name: 172, dtype: float64)
(173, Age           -0.200874
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K        0.368382
```

```
Drug           0.000000
Name: 173, dtype: float64)
(174, Age           -0.140278
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.460525
Drug           1.000000
Name: 174, dtype: float64)
(175, Age            1.738179
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        0.314121
Drug           0.000000
Name: 175, dtype: float64)
(176, Age            0.223294
Sex            1.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K       -0.782485
Drug           1.000000
Name: 176, dtype: float64)
(177, Age           -1.170400
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K        0.406129
Drug           0.000000
Name: 177, dtype: float64)
(178, Age           -0.322065
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.016027
Drug           0.000000
Name: 178, dtype: float64)
(179, Age            1.374607
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.026851
Drug           0.000000
Name: 179, dtype: float64)
(180, Age           -1.352186
Sex            0.000000
BP             0.000000
Cholesterol    1.000000
Na_to_K        0.934448
Drug           0.000000
Name: 180, dtype: float64)
(181, Age            0.889843
Sex            0.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.305374
Drug           4.000000
Name: 181, dtype: float64)
(182, Age           -1.473377
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.610403
Drug           4.000000
```

```
Name: 182, dtype: float64)
(183, Age           -0.503851
Sex             0.000000
BP              0.000000
Cholesterol     1.000000
Na_to_K        -0.082500
Drug            0.000000
Name: 183, dtype: float64)
(184, Age           -1.594568
Sex             0.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K         2.928655
Drug            0.000000
Name: 184, dtype: float64)
(185, Age            0.768653
Sex             0.000000
BP              2.000000
Cholesterol     1.000000
Na_to_K         1.361183
Drug            0.000000
Name: 185, dtype: float64)
(186, Age            1.556393
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K        -0.865334
Drug            2.000000
Name: 186, dtype: float64)
(187, Age            0.162699
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K        -0.788452
Drug            1.000000
Name: 187, dtype: float64)
(188, Age            1.253416
Sex             1.000000
BP              0.000000
Cholesterol     1.000000
Na_to_K         2.624597
Drug            0.000000
Name: 188, dtype: float64)
(189, Age            1.192821
Sex             1.000000
BP              0.000000
Cholesterol     1.000000
Na_to_K         0.672717
Drug            0.000000
Name: 189, dtype: float64)
(190, Age            0.829248
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K         0.403354
Drug            0.000000
Name: 190, dtype: float64)
(191, Age           -1.291591
Sex             1.000000
BP              0.000000
Cholesterol     0.000000
Na_to_K        -1.120403
Drug            1.000000
Name: 191, dtype: float64)
```

```
(192, Age            1.677584
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K        0.031296
Drug           0.000000
Name: 192, dtype: float64)
(193, Age            1.677584
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -1.292763
Drug           3.000000
Name: 193, dtype: float64)
(194, Age            0.102103
Sex            0.000000
BP             0.000000
Cholesterol    0.000000
Na_to_K        2.581438
Drug           0.000000
Name: 194, dtype: float64)
(195, Age            0.708057
Sex            0.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.626917
Drug           3.000000
Name: 195, dtype: float64)
(196, Age           -1.715759
Sex            1.000000
BP             1.000000
Cholesterol    0.000000
Na_to_K       -0.565995
Drug           3.000000
Name: 196, dtype: float64)
(197, Age            0.465676
Sex            1.000000
BP             2.000000
Cholesterol    0.000000
Na_to_K       -0.859089
Drug           4.000000
Name: 197, dtype: float64)
(198, Age           -1.291591
Sex            1.000000
BP             2.000000
Cholesterol    1.000000
Na_to_K       -0.286500
Drug           4.000000
Name: 198, dtype: float64)
(199, Age           -0.261469
Sex            0.000000
BP             1.000000
Cholesterol    1.000000
Na_to_K       -0.657170
Drug           4.000000
Name: 199, dtype: float64)
```

In [ ]: