Manage Azure Key Vault

(LAB-204-13-01)

Lab scenario

You have been asked to create a proof-of-concept application that makes use of the Azure SQL Database support for Always Encrypted functionality. All of the secrets and keys used in this scenario should be stored in the key vault. The application should be registered in Azure Active Directory (Azure AD) in order to enhance its security posture. To accomplish these objectives, the proof of concept should include:

- Creating an Azure key vault and storing keys and secrets in the vault.
- Create a SQL Database and encrypting content of columns in database tables by using Always Encrypted.

Lab exercises

- Configure the key vault with a key and a secret.
- Create an application to demonstrate using the key vault for encryption.

Task 1: Provision Resources

Step 1: Review the ARM Template

1. Open the **az-204-13-01_azuredeploy.json** and **az204-13-01_ azuredeploy.parameters.json** file in notepad and review its content.

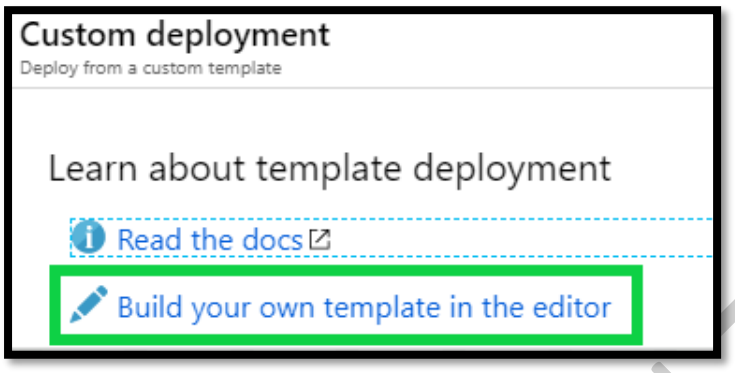
Note: **JSON** template provided with the lab manual.

Step 2: Deploy the Resources

2. From the Azure Portal, go to the left menu, select **Create a resource**
3. Search and Select **Template deployment**

4. Select **Create**

5. Select **Build your own template in the editor**

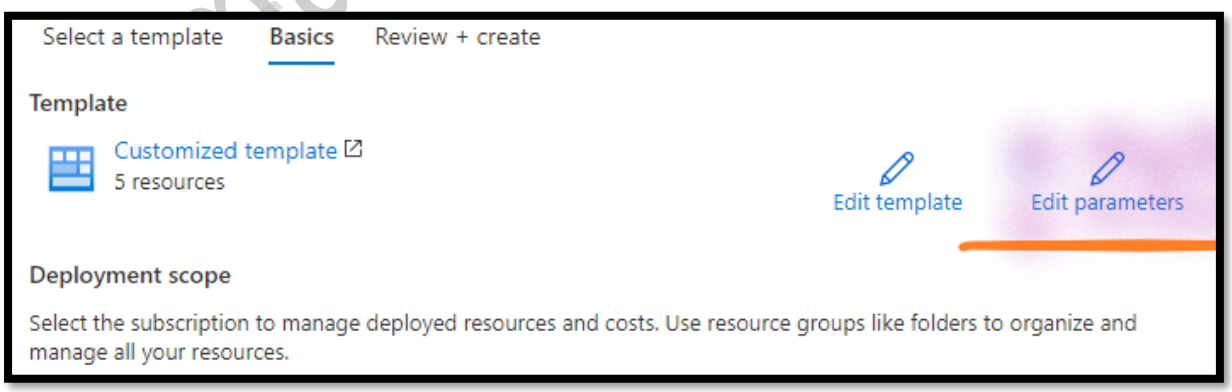


6. On the **Edit template** blade, click **Load file** and **select** and upload the **az-204-13-01_azuredeploy.json** file.

Note: **JSON** template provided with the lab manual.

7. Click **Save**

8. It will open the **Custom deployment** blade, click on the **Edit parameters** blade.



9. Click **Load file** and **select** and upload the **az204-13-01_azuredeploy.parameters.json** file.

10. It will open the **Custom deployment** blade. Provide the following **details**:

    i. **Subscription**: Select your **Default subscription**

    ii. **Resource Group**: Select **Create new** and provide resource group name **Az-204-13-01-RG**.

    iii. **Region**: Dropdown Select **East US**

> **Note**: Leave other details as default.

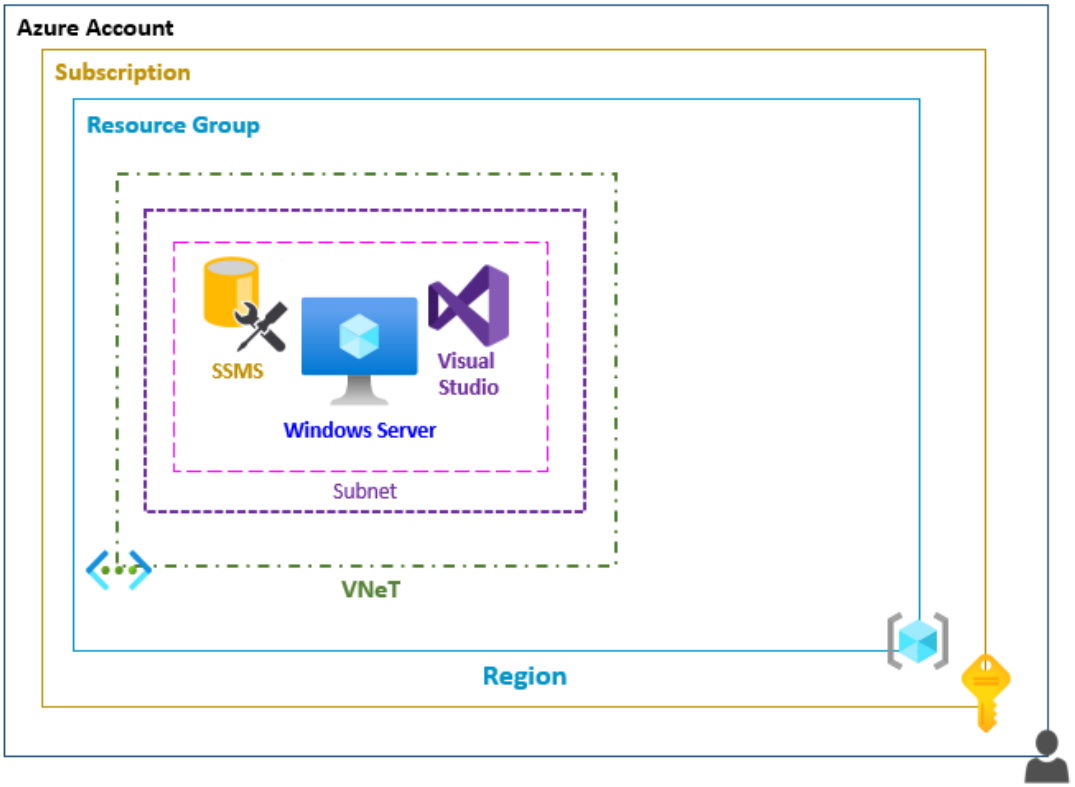
11. Select **Next: review + Create**

12. Select **Create**

> **Note**: Wait for deployment completion. You can verify this from Notification icon.

Task 2: Install Tools

In this task, you will deploy an Azure VM, connect to it, and download and install Visual Studio 2019 and SQL Server Management Studio (SSMS).



Step 1: Connect to Virtual Machine

13. Go to the left side of the menu, select **virtual machines**.
14. Select & open the virtual machine **az204-13-vm** from the list.
15. On the right side of the page copy **Public IP Address**.
16. In the local Desktop/ Laptop (Windows 10), right click on **Start** & **Run**.
17. In the open, write **mstsc**.
18. Enter in the **Public IP Address** of the Azure virtual machine, and then click **Connect**.

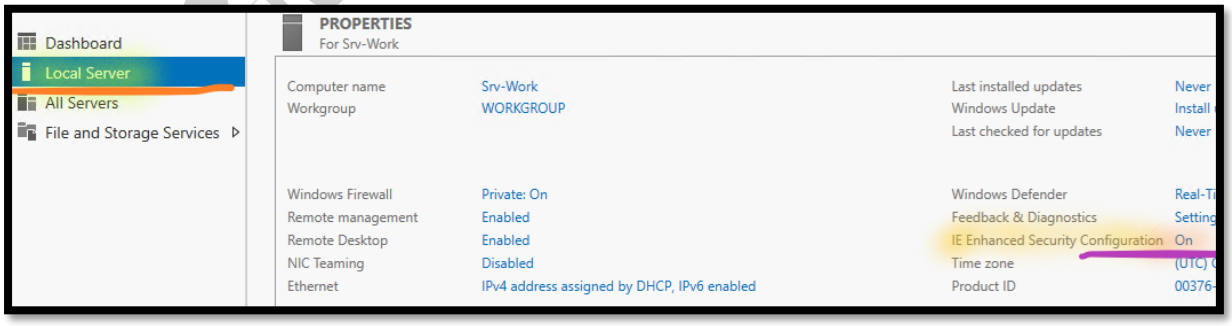
Info: When prompt for username & password, provide below details.

Username: **master**

Password: **Lab@password**

Step 2: Connect to Work Server

19. From the **az204-13-vm** server (Windows 2019), right click on **Start** & **Run**.
20. In the open, write **servermanager.exe**.
    a. Click **Local Server**.
    b. Click **IE Enhanced Security Configuration**.



    c. Click **On**, next to **IE Enhanced Security Configuration**.
    d. Set both options to **Off**.

e. Click **Ok**.

Step 3: Install SSMS and Visual Studio

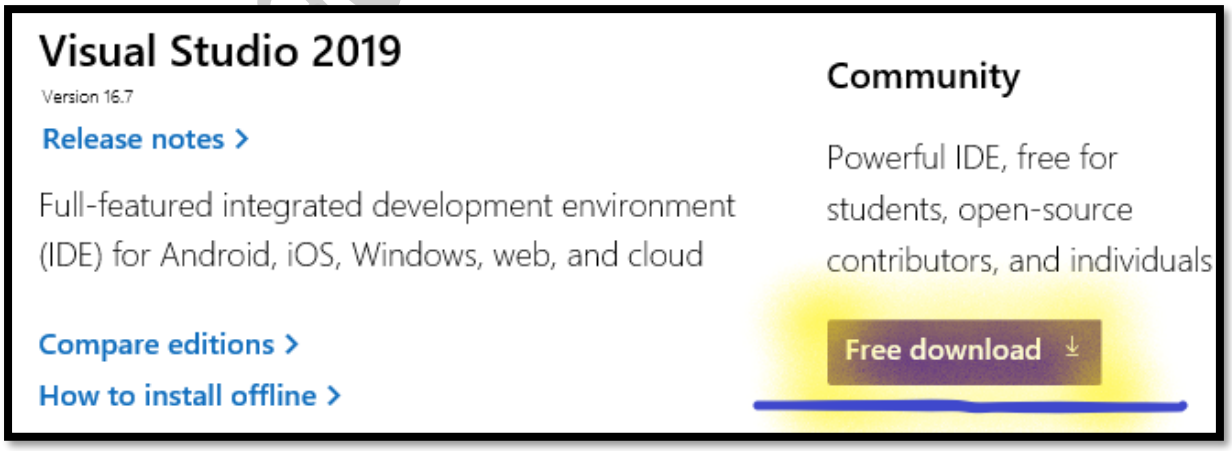
21. Download and Install **SQL Server Management Studio** (SSMS) using the below URL.

    https://docs.microsoft.com/en-us/sql/ssms/download-sql-server-management-studio-ssms?view=sql-server-ver15

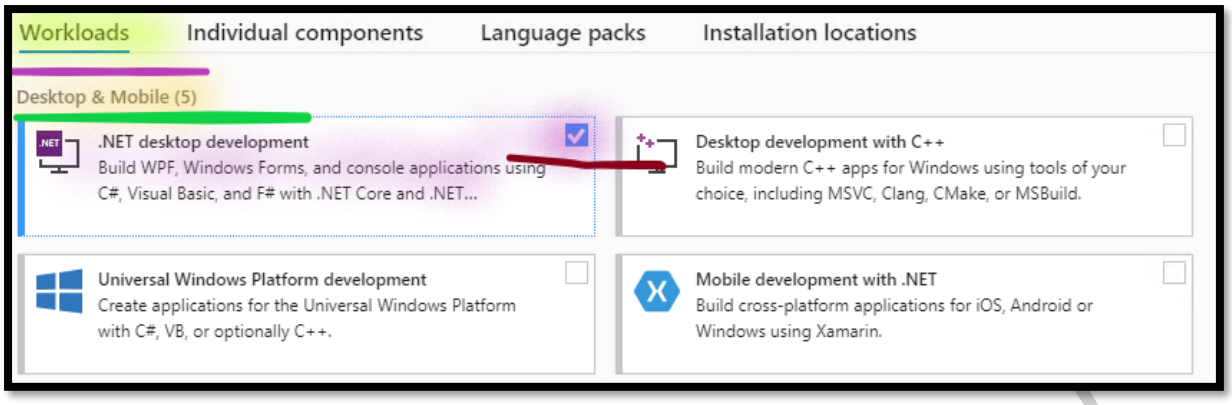
22. Install **Visual Studio** using the below URL.

    https://visualstudio.microsoft.com/downloads/

    a. Select **Community edition** and **download**



    b. In the **Workloads** window, in the **Desktop & Mobile** section, **select** the **.NET desktop development** **checkbox**

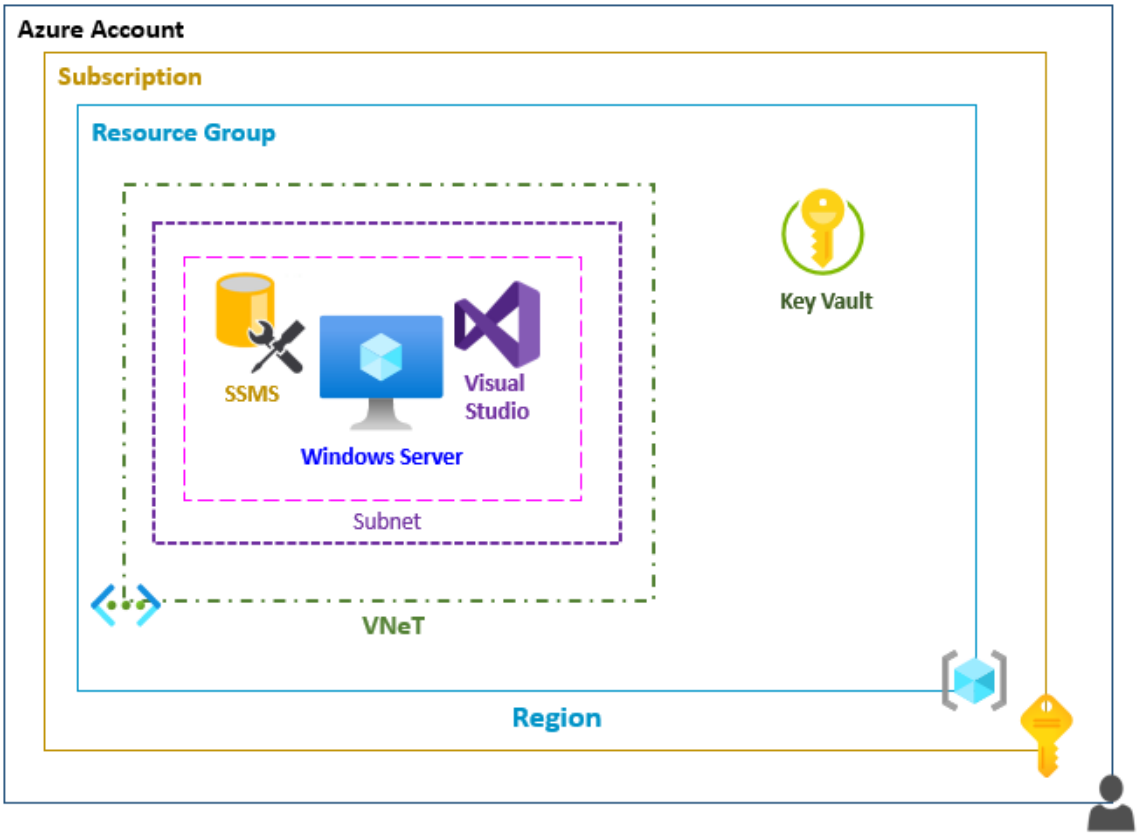


c. Click **Install**.

Note: Visual studio installation takes **~ 15 mnts. Don't wait**, goto the next step.

Task 3: Create Azure Key Vault

In this task, you will create a lab resource group and a key vault. You will also configure the key vault permissions.



Step 1: Create Azure Key Vault

23. From the Azure Portal, **go to the left menu**, select **Create a resource**.

24. Search and Select **Key Vault** from the list

25. Select **Create** and **configure**:

    a. **Subscription:** Select **default subscription**

    b. **Resource group:** Select **existing** resource group **Az-204-13-01-RG**

    c. **Key Vault name:** Provide key vault name **lab204keyvault123**

Note: **Replace 123** to make unique name.

    d. **Region**: Select region **East US**

    e. **Pricing tier**: Select **Standard**

Note: Leave other options as default.

    f. Select **Next: Access policy**

Note: Leave other options as default.

    g. Select **Next: Networking**

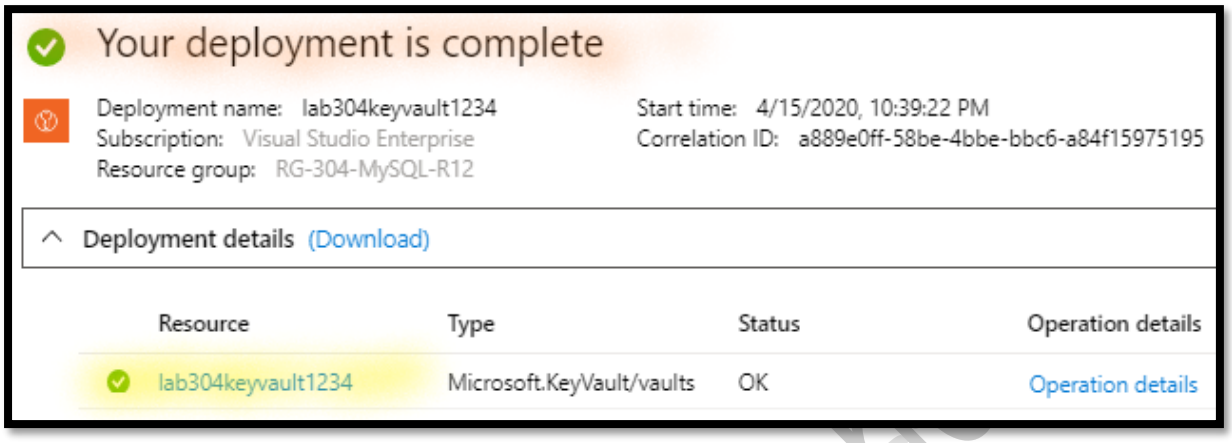
Note: Leave other options as default.

    h. Select **Next: Tags**

    i. Select **Next: Review + Create**

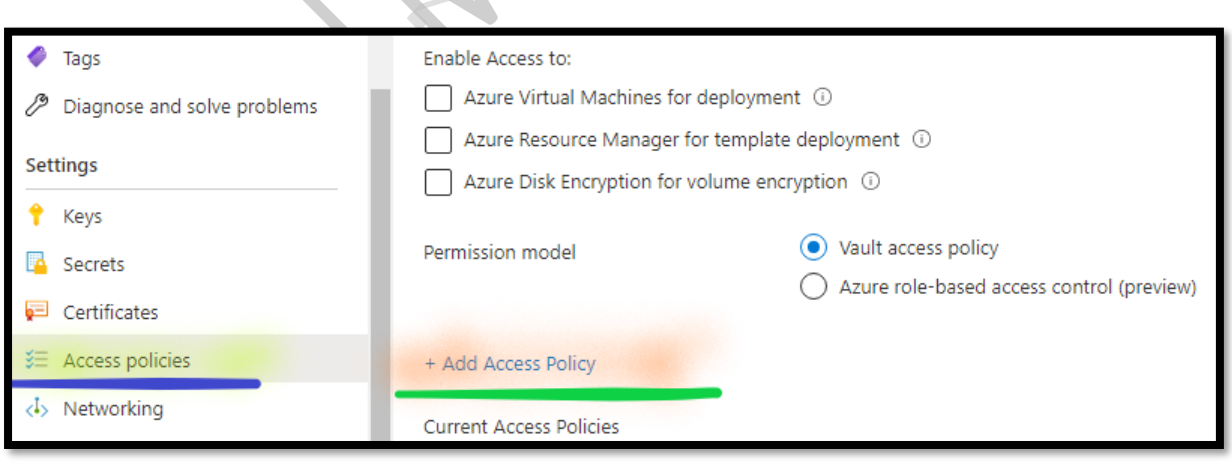
j. Select **Create**

Note: **Wait** (~**5 mnts**.) till deployment gets completed.



Step 2: Configure Access Policy

26. From the **Azure Portal**, go to the left menu, select **resource group**
27. Open resource group **Az-204-13-01-RG**
28. Open Key Vault **lab204keyvault123**
29. Select **Access policies** under **settings**
30. Select **Add access policy** and **Configure**:



a. **Configure from template**: Dropdown and select **Key, Secret, & Certificate Management**

b. **Key permissions**: Dropdown and select **Select All**

Note: You can see the **16 permissions** selected.

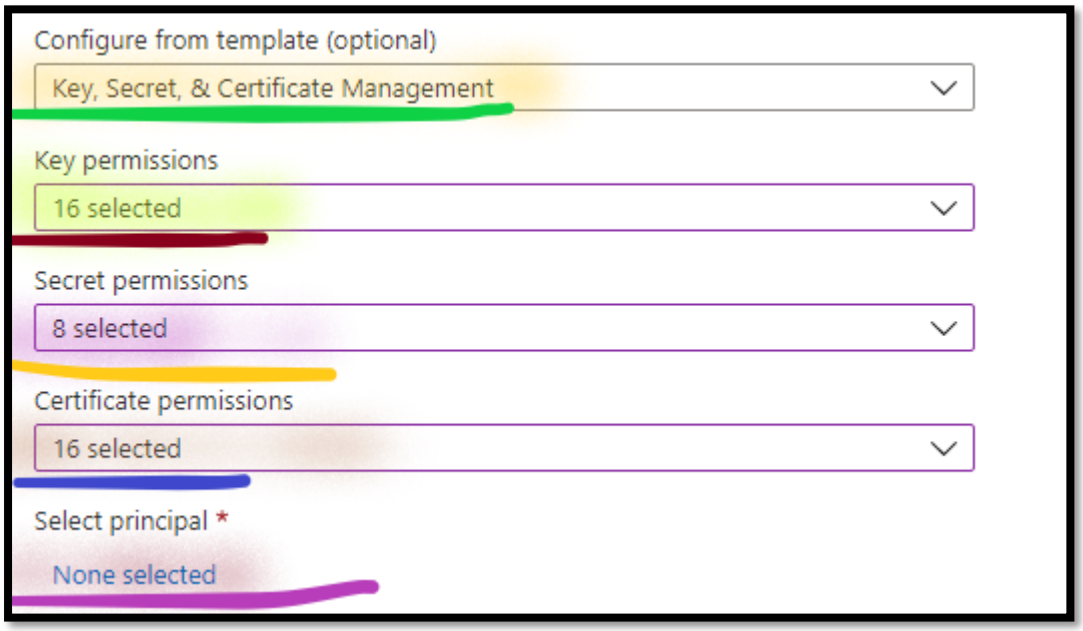
c. **Secret permissions**: Dropdown and select **Select All**

Note: You can see the **8 permissions** selected.

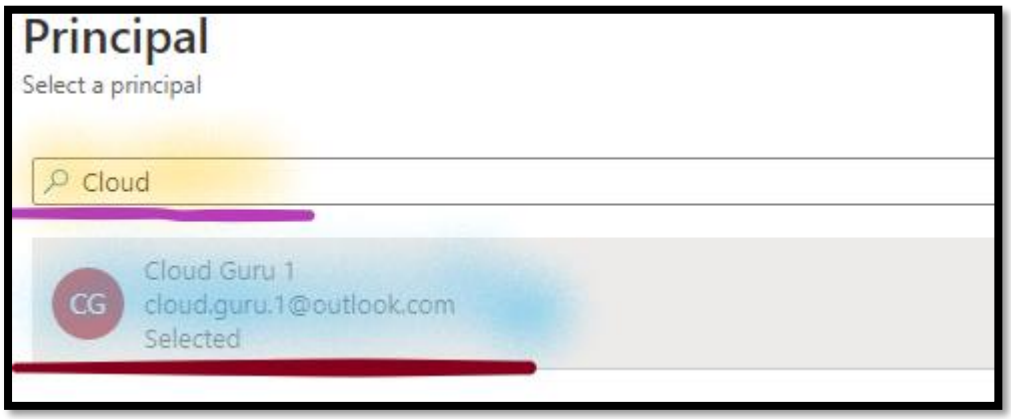
d. **Certificate permissions**: Dropdown and select **Select All**

Note: You can see the **16 permissions** selected.

e. **Select principal**: Click **None selected**



i. On the **Principal** blade, search and select **root user account**



ii. Click **Select**

f. Select **Add**

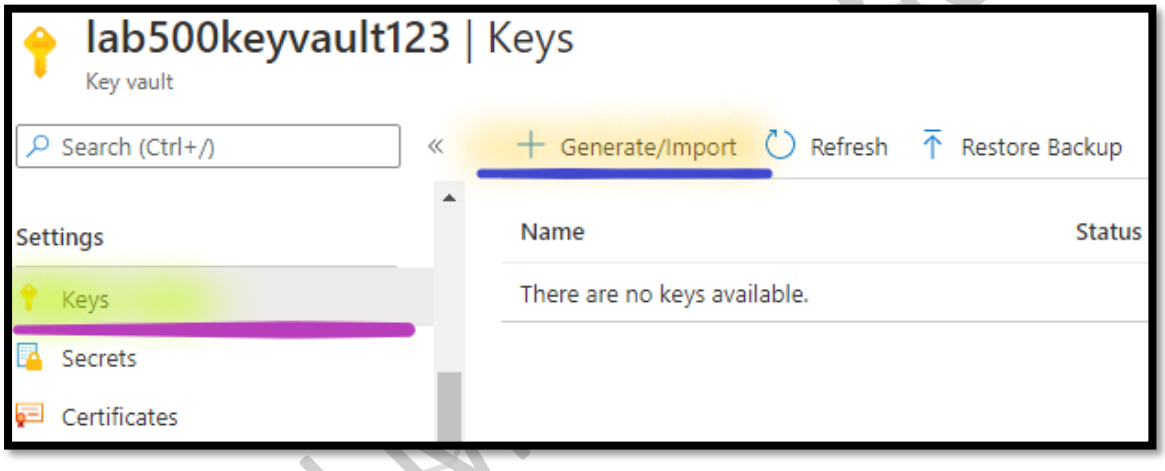
31. Select **Save**

Step 3: Create Keys

In this task, you will add a key to the key vault to know how to add the key in Key vault. This is not going to use in C# code.

32. Select **Keys** under **settings**

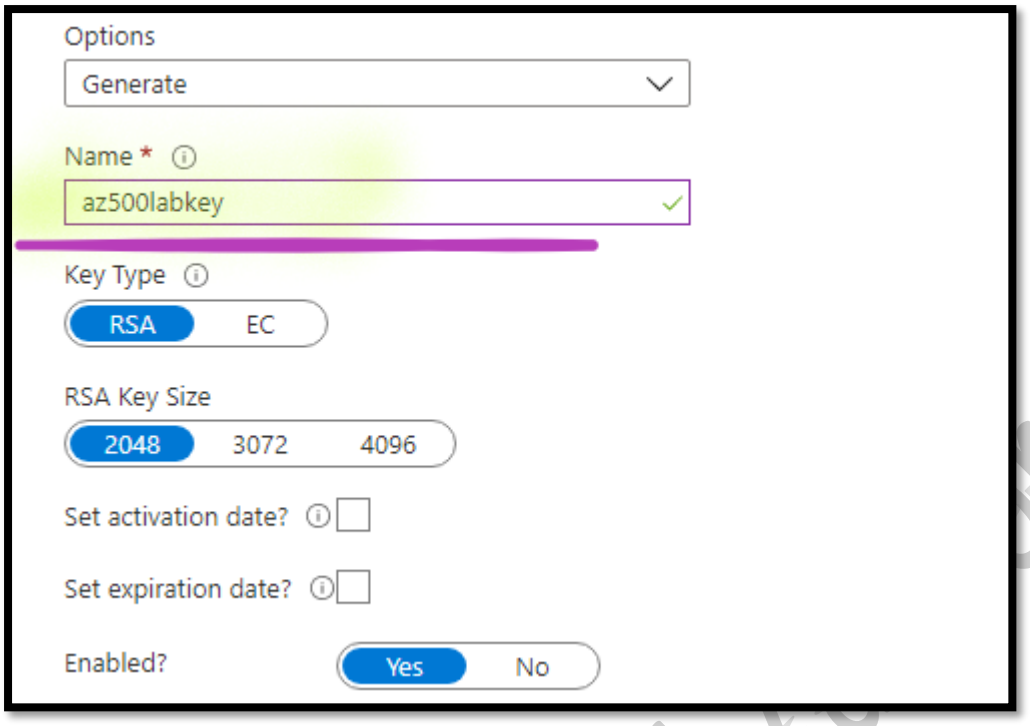
33. Select **Generate/ Import** and **Configure:**



a. **Options**: Dropdown & Select **Generate**

b. **Name**: Write **Az204LabKey**

Note: Leave other options as default.



c. Select **Create**

Step 4: Create Secrets

In this task, you will add a secret to the key vault to know how to add the Secret in Key vault. This is not going to use C# code.

34. Select **Secrets** under **settings**
35. Select **Generate/ Import** and **Configure**
    a. **Options**: Dropdown & Select **Manual**
    b. **Name**: Write **SQLPassword**
    c. **Value**: Write **Pa55w.rd1234**

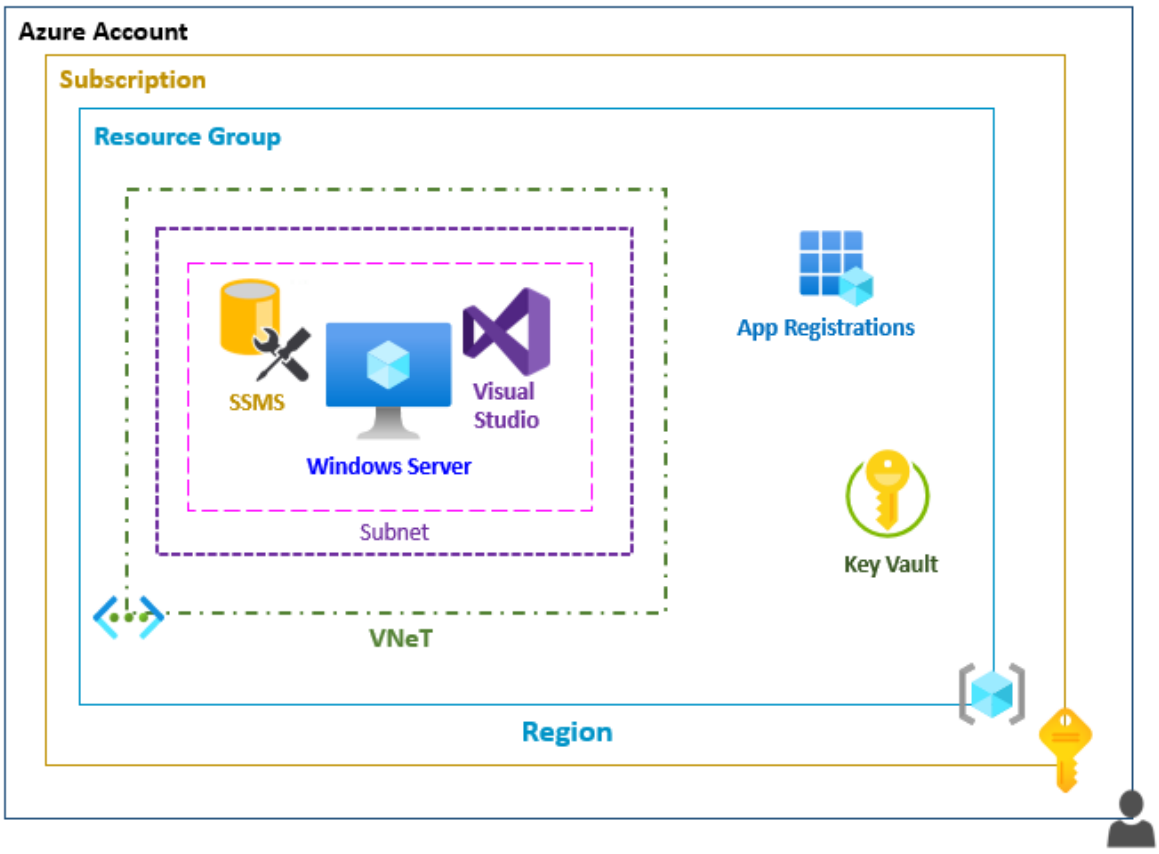
Note: Leave other options as default.

d. Select **Create**

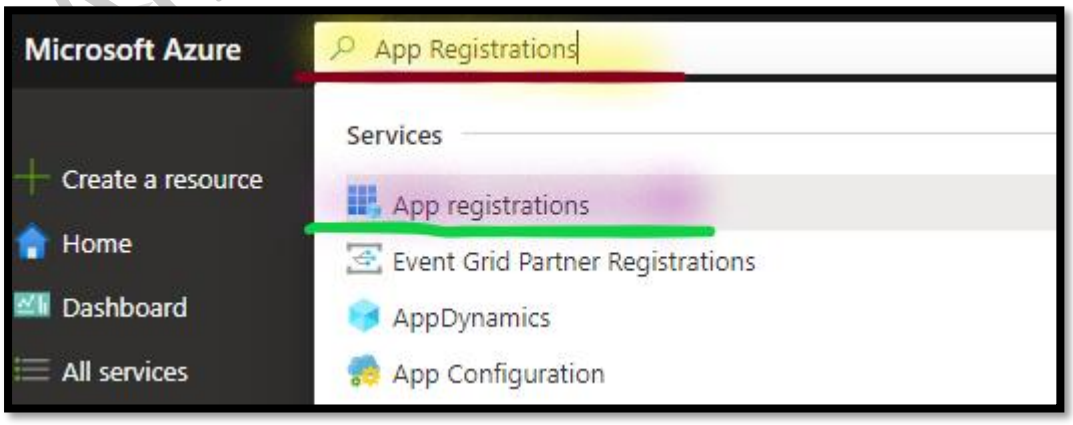
Task 4: Create an Application to use the Key Vault for Encryption

Step 1: Enable a client application to access the Azure SQL Database service

In this task, you will enable a client application to access the Azure SQL Database service. This will be done by setting up the required authentication and acquiring the Application ID and Secret that you will need to authenticate your application.

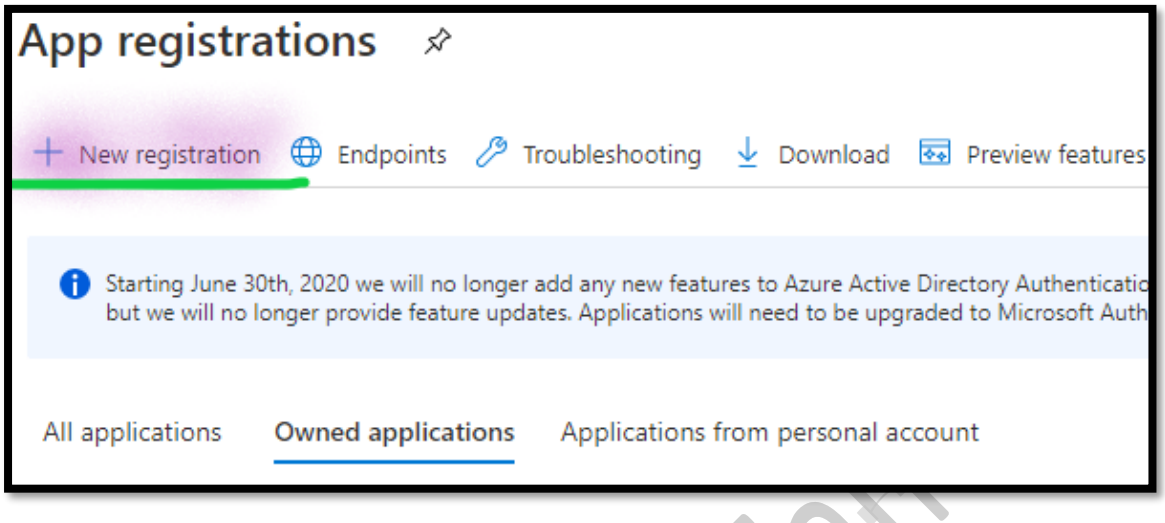


36. In the Azure portal, in the Search resources, services, and docs text box at the top of the Azure portal page, type **App Registrations**.



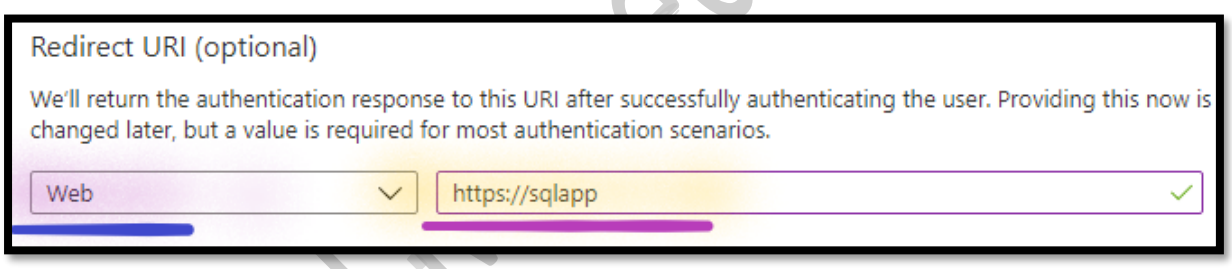
37. Select **App registrations**

38. Click **New registration** and **Configure**:



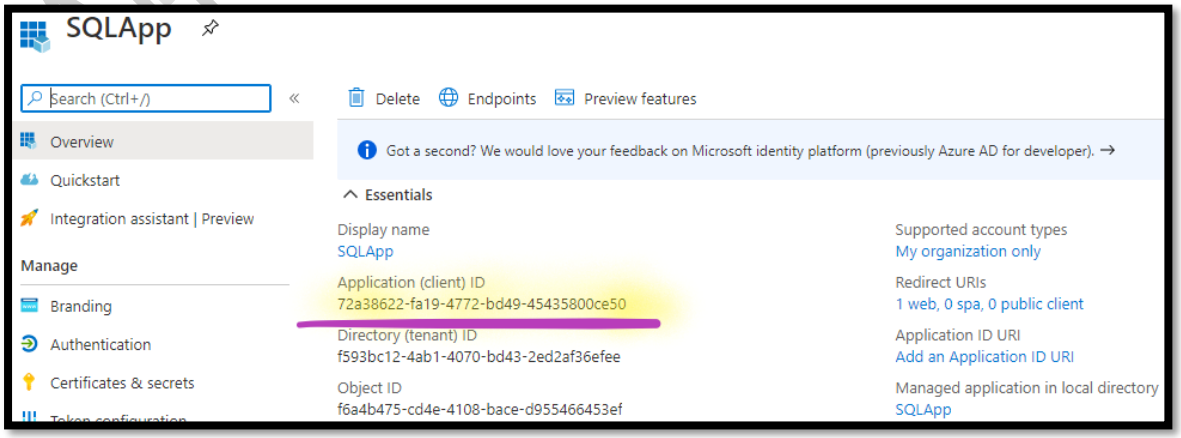
a. **Name**: Write **SQLApp**

b. **Redirect URI**: Dropdown and select **Web** and write **https://sqlapp**



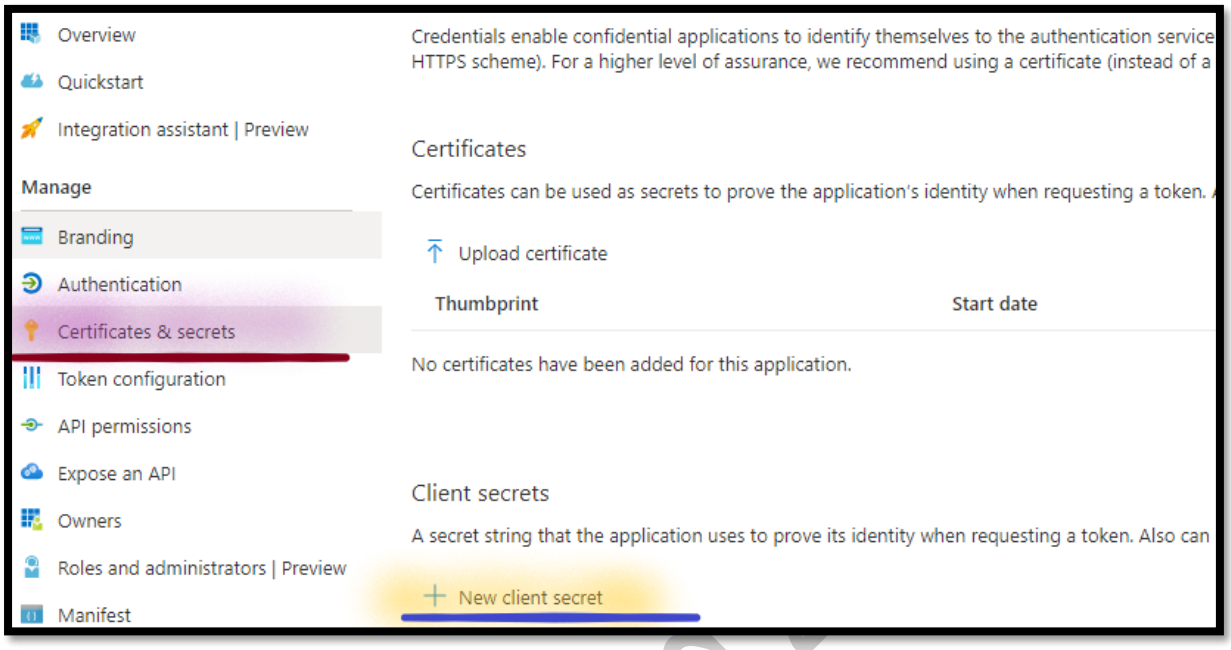
c. Click **Register**.

39. On the **SQLApp** blade, Select **Overview**, identify the value of **Application (client) ID** and copy this in **Notepad**.



40. Click **Certificates and Secrets** under **Manage**

41. Click **New client secret** and **Configure:**

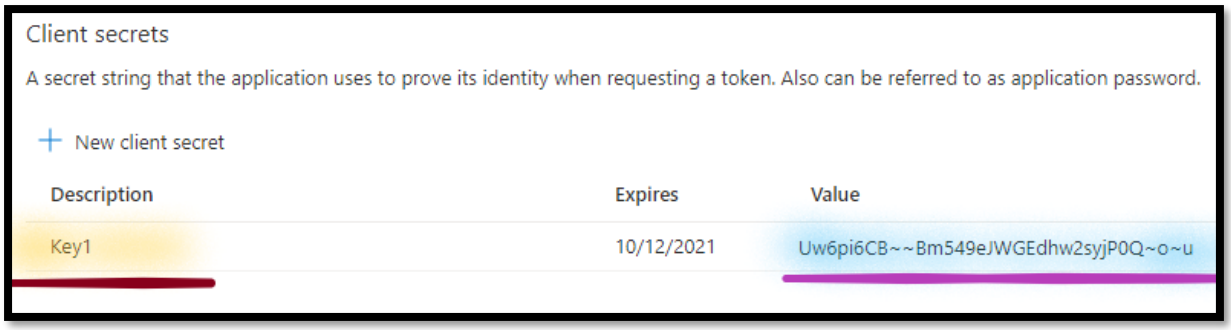


a. **Description**: Write **Key1**

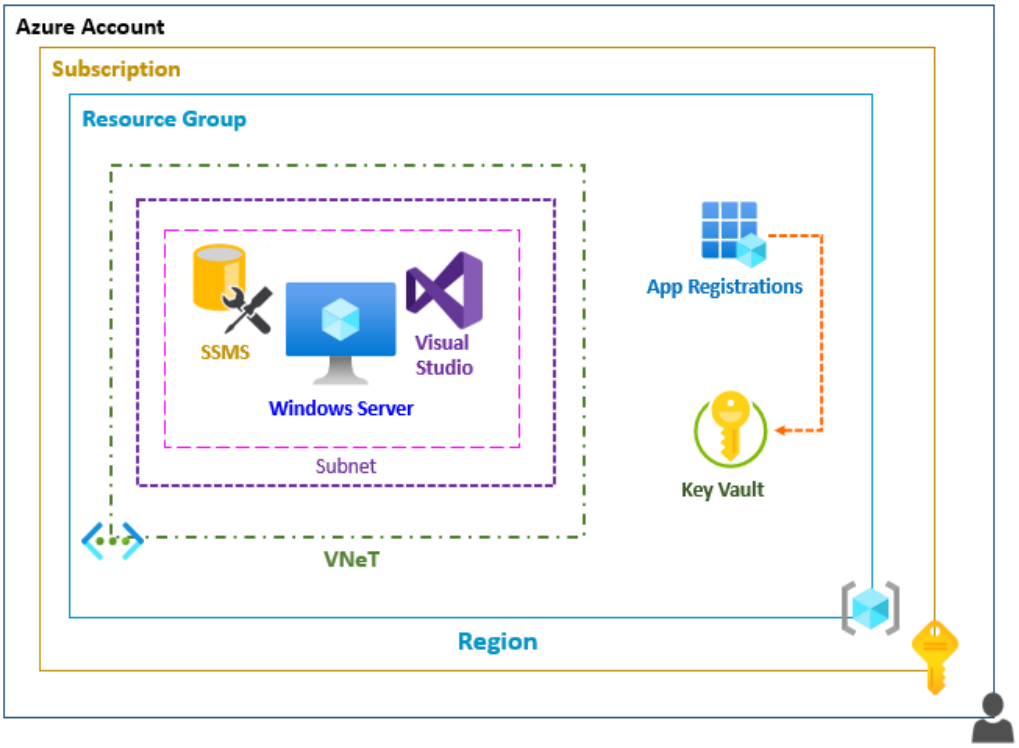
b. **Expires**: Select **1 year**

c. Click **Add**

42. On the **SQLApp** blade, Select **Certificates & secrets** blade, identify the **value** of **Key1** and copy this in **Notepad**.



Step 2: Create a policy allowing the application access to the Key Vault

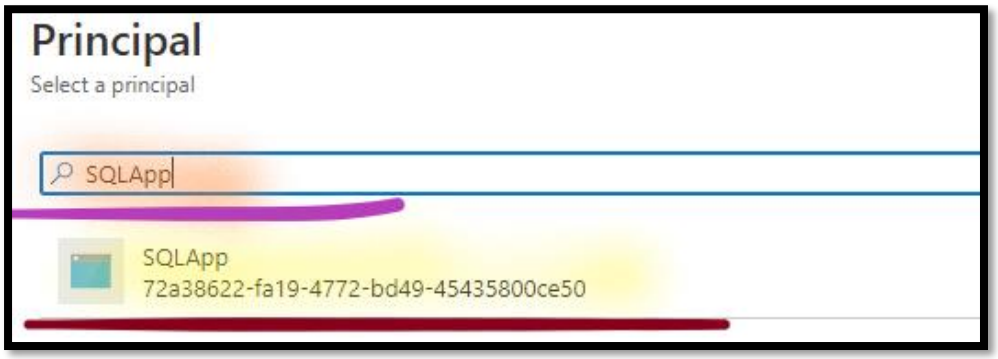


43. From the **Azure Portal**, go to the left menu, select **resource group**
44. Open resource group **Az-204-13-01-RG**
45. Open Key Vault **lab204keyvault123**
46. Select **Access policies** under **settings**
47. Select **Add access policy** and **Configure**:
    a. **Key permissions**: Dropdown and select **get**, **list**, **unwrapKey**, **wrapKey**, **verify**, **sign**.

Note: You can see the **6 permissions** selected.

b. **Select principal**: Click **None selected**.

i. On the **Principal** blade, search and select **SQLApp**.



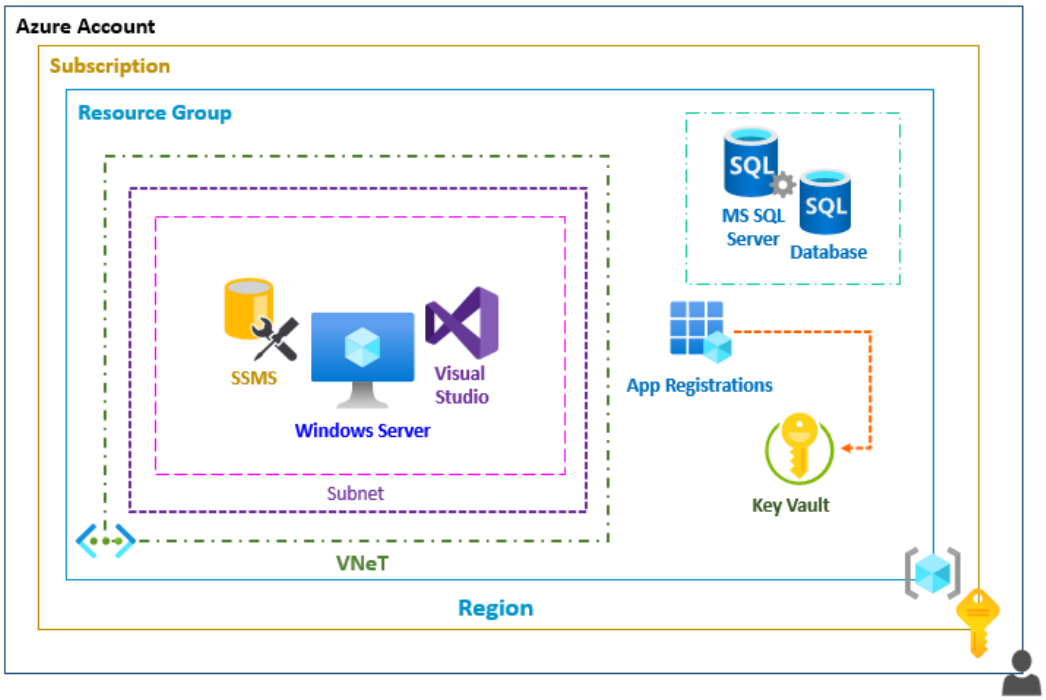
ii. Click **Select**

c. Select **Add**

48. Select **Save**

Task 5: Create Azure SQL Database

Step 1: Create Azure SQL Logical Server with SQL Database

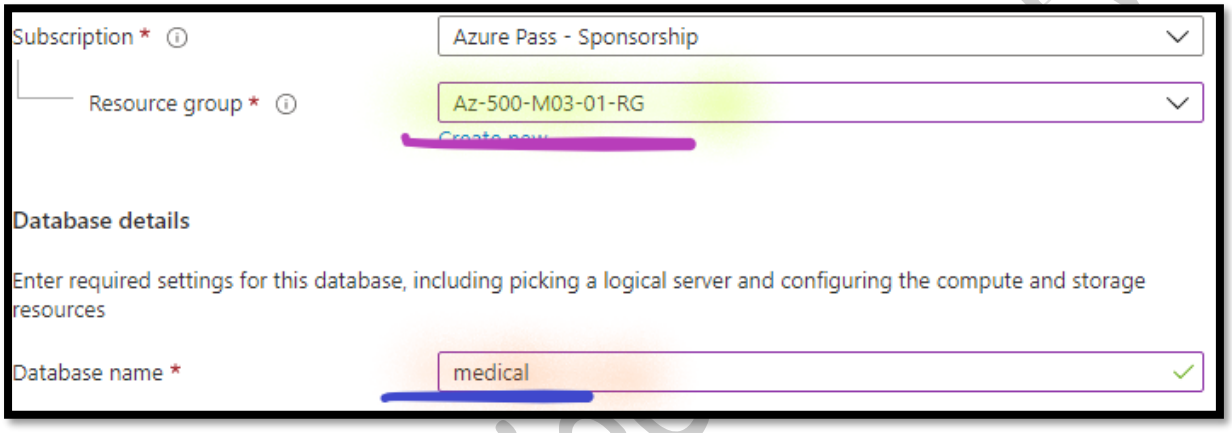


49. Click the **Create resource** link in the left-hand navigation bar.

50. Search and Select the **SQL Database**

51. Click **Create**, & **configure**:

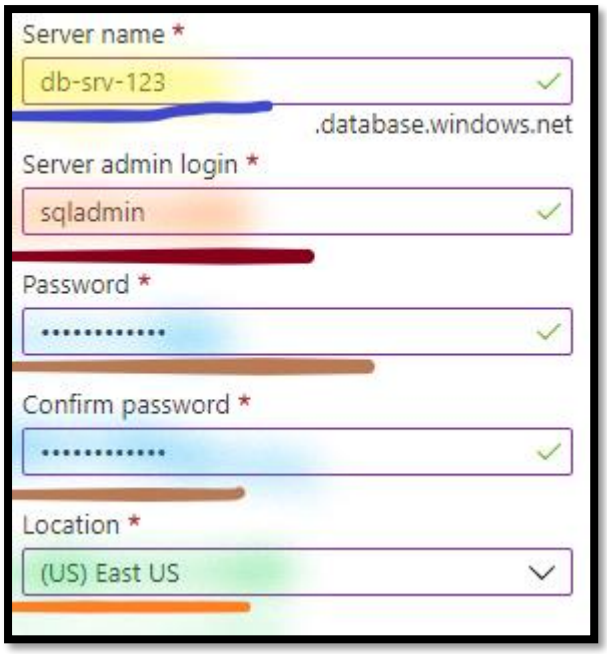
    a. **Subscription**: Select **default subscription**
    b. **Resource group**: Select **existing** resource group **Az-204-13-01-RG**
    c. **Database name**: Write **medical**



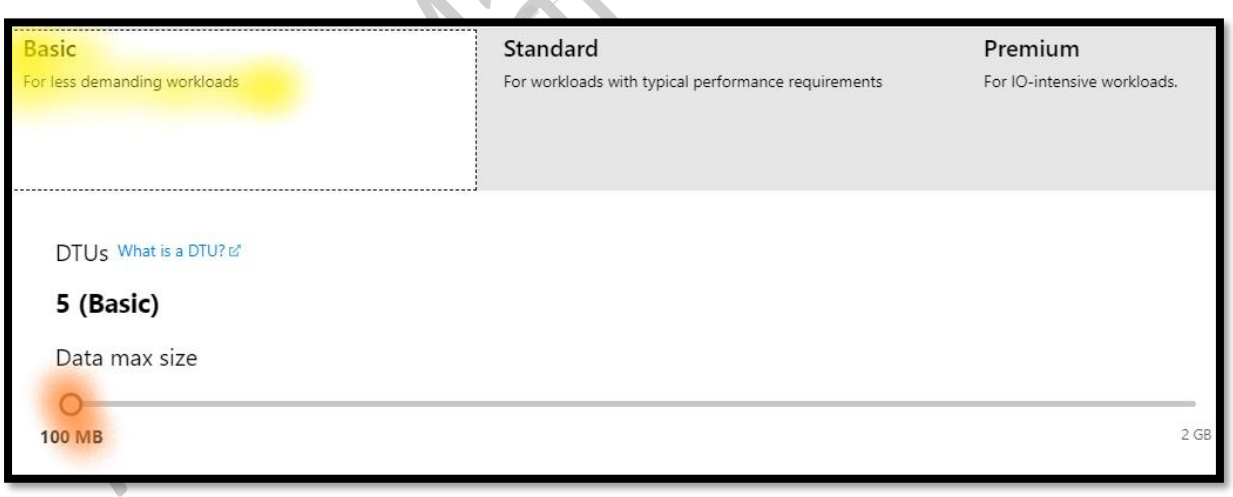
    d. **Server**: Select **Create new** and **Configure**:
        i. **Server name**: Provide server name **db-srv-123**

Note: **Replace 123** to make the db server name unique.

        ii. **Server admin login**: Provide admin name **sqladmin**
        iii. **Password**: Provide password **Lab-Password**
        iv. **Confirm password**: Provide password **Lab-Password**
        v. **Location**: Select **East US**



e. **Compute + Storage**: Click on **Configure database**
   i. Click on **Looking for basic, standard, premium**
   ii. Select **Basic**
   iii. **Data max size**: Use slider to Select **minimum size**
   iv. Select **Apply**



f. Click **Next: Networking**

Note: Leave all the options as default.

g. Click **Next: Additional settings**

Note: Leave all the options as default.

h. Click **Next: Tags**

Note: Leave all the options as default.

i. Click **Next: Review + Create**

j. Click **Create**

Note: **Wait** until your deployment gets completed.

Step 2: Copy the Virtual Machine IP address

52. Go to the left side of the menu, select **virtual machines**.

53. Select & open the virtual machine **az204-13-vm** from the list.

54. On the right side of the page copy **Public IP Address**.

Step 3: Enable the Firewall Setting

55. From the Azure Portal, go to the left menu, select **resource group**

56. Open resource group **Az-204-13-01-RG**

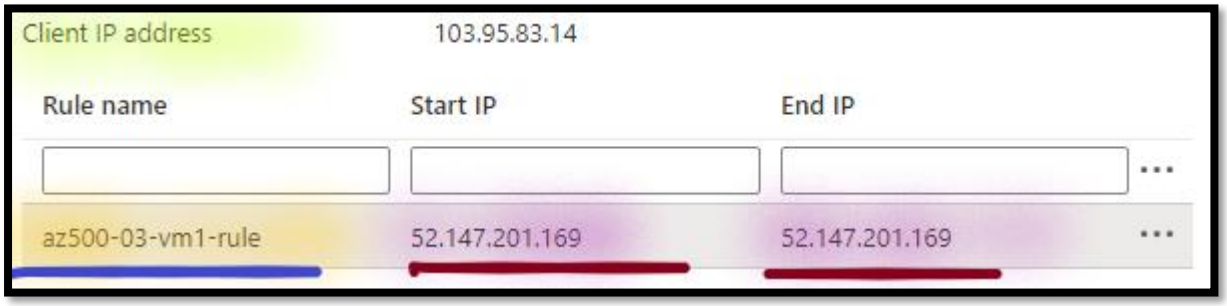
57. Open SQL database **medical**

58. Select **Set server firewall**

    a. **Rule name**: Write **az204-13-vm -rule**

    b. **Start IP**: Write **Public IP Address** **az204-13-vm** virtual machine

    c. **End IP**: Write **Public IP Address** **az204-13-vm** virtual machine



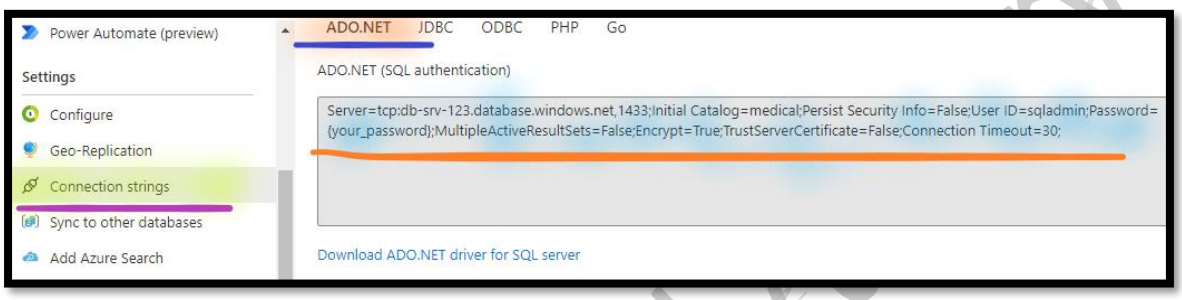
d. Select **Save**

Step 4: Copy the Connection string

59. Select **Connection string** under **settings**

60. Select **ADO.NET**

61. Copy **ADO.NET** **Connection string** in the **Notepad**.



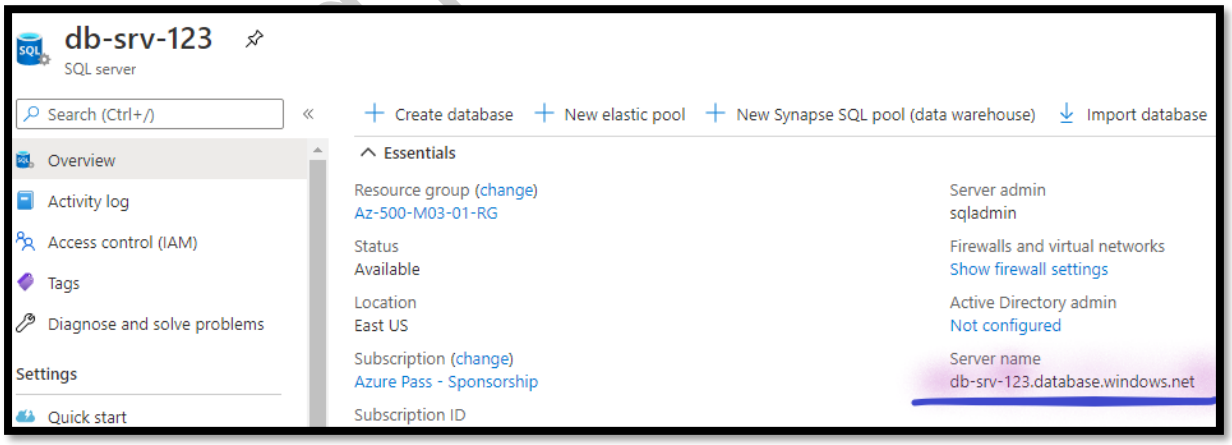
Step 5: Copy the SQL Server name

62. From the Azure Portal, go to the left menu, select **resource group**

63. Open resource group **Az-204-13-01-RG**

64. Open SQL server **db-srv-123**

65. Copy the **Server name** in the **Notepad**.



Step 6: Connect to Virtual Machine

66. In the local Desktop/ Laptop (Windows 10), right click on **Start** & **Run**.

67. In the open, write **mstsc**.

68. Enter in the **Public IP Address** of the Azure virtual machine, and then click **Connect**.

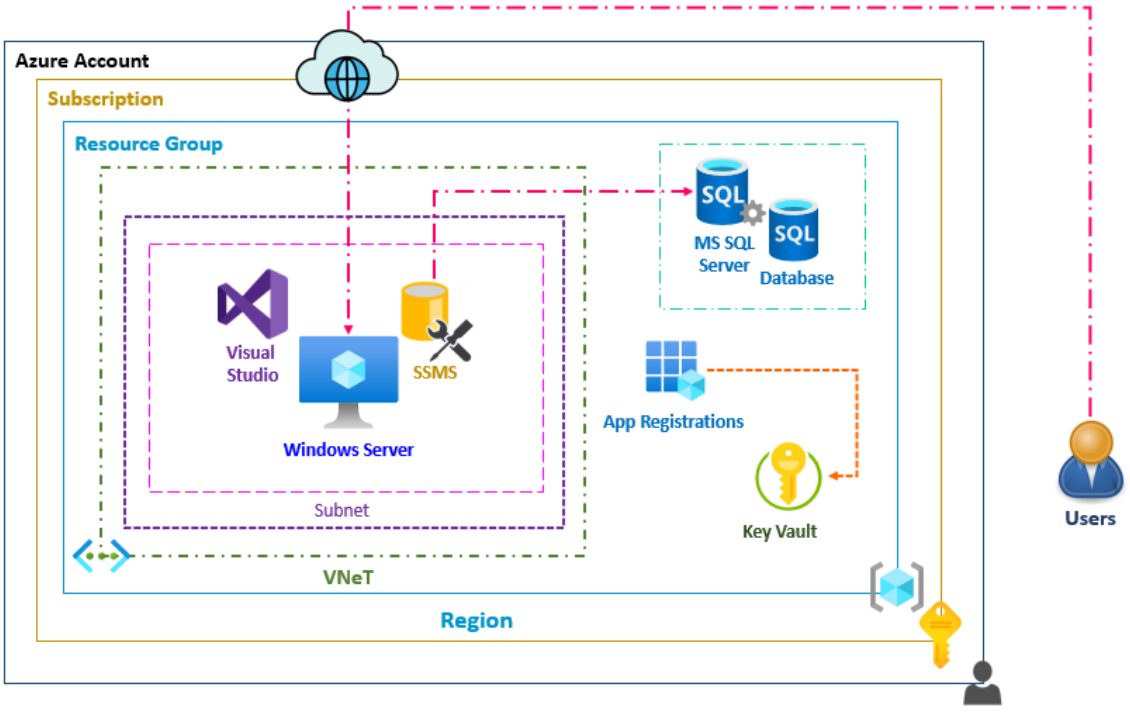
69. Enter the **Username** and **Password** of the Azure virtual machine and click **Ok**.

Info: When prompt for username & password, provide below details.

Username: **master**

Password: **Lab@password**

Step 7: Connect to SQL Server



70. From the **az204-13-vm** virtual machine, Right click on **Start** & **Run**. In the open, **write**

    C:\Program Files (x86)\Microsoft SQL Server Management Studio 18\Common7\IDE\SSMS

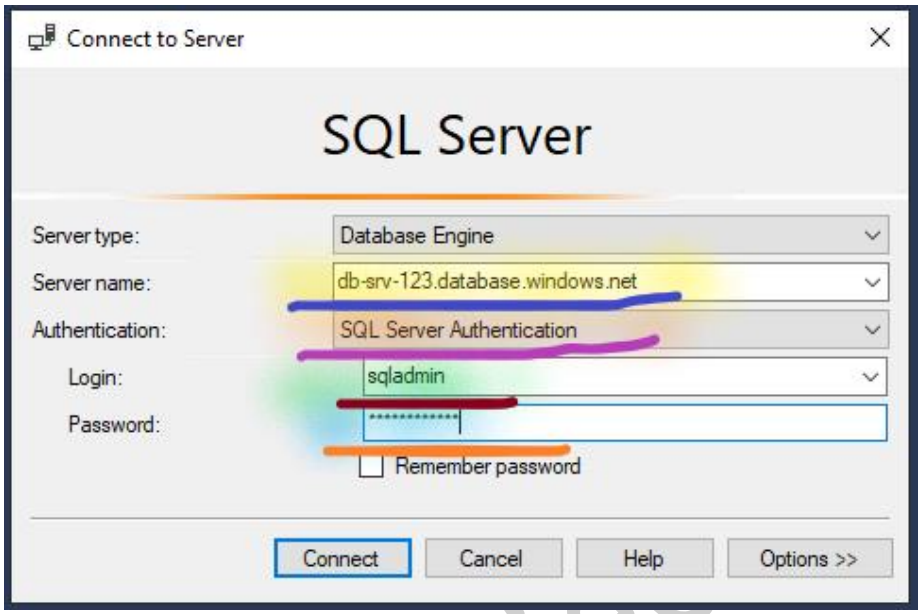
    a. **Server type:** Dropdown and Select **Database Engine**

b. **Server name:** Copy the **db-srv-123** **Server name**

c. **Authentication:** Dropdown and Select **SQL server authentication**

i. **Server admin login**: Write **sqladmin**

ii. **Password**: Write **Lab-Password**



d. Select **Connect**

Step 8: Create Table

71. From the **SQL Management Studio (SSMS)**

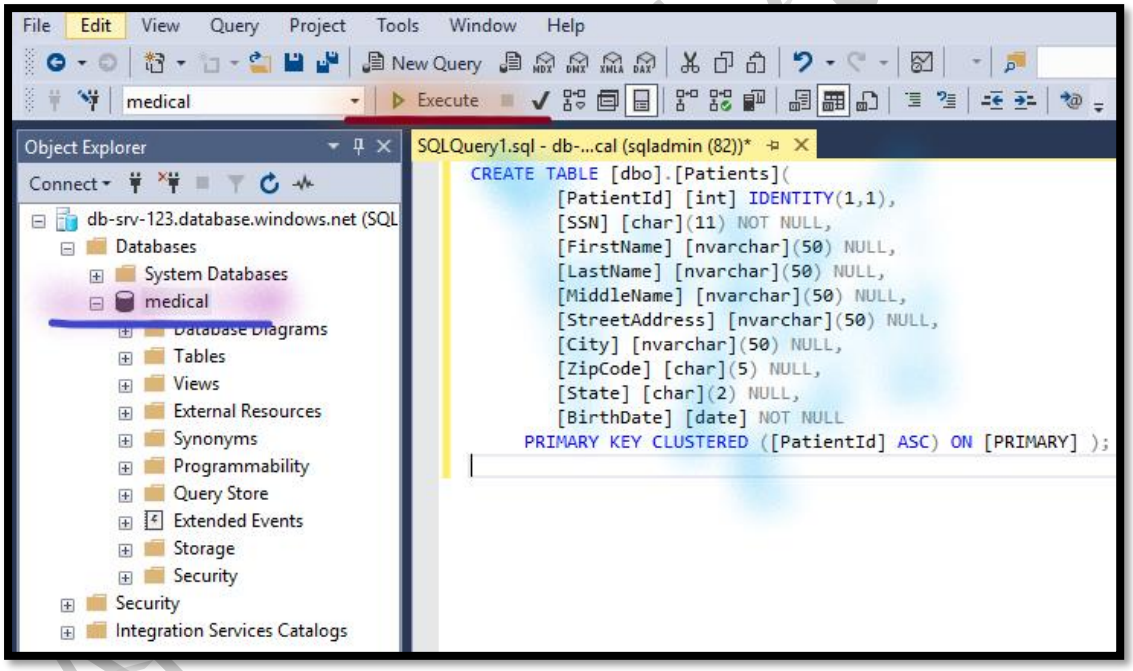
a. Expand **Databases**

b. **Right click** on **medical** database

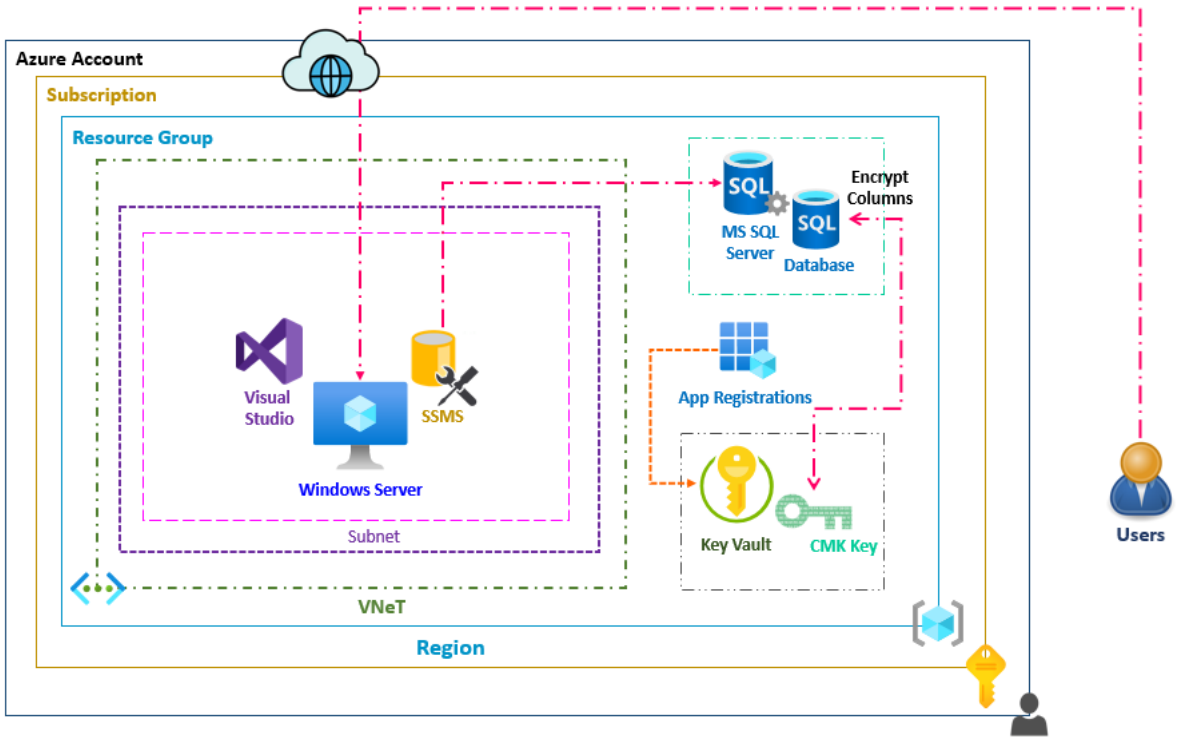
c. Select **New Query**

d. Paste the below **code** into the query window and click **Execute** to create a **Patients table**.

```
CREATE TABLE [dbo].[Patients](
        [PatientId] [int] IDENTITY(1,1),
        [SSN] [char](11) NOT NULL,
        [FirstName] [nvarchar](50) NULL,
        [LastName] [nvarchar](50) NULL,
        [MiddleName] [nvarchar](50) NULL,
        [StreetAddress] [nvarchar](50) NULL,
        [City] [nvarchar](50) NULL,
        [ZipCode] [char](5) NULL,
        [State] [char](2) NULL,
        [BirthDate] [date] NOT NULL
    PRIMARY KEY CLUSTERED ([PatientId] ASC) ON [PRIMARY] );
```



Step 9: Encrypt Columns



72. From the **SQL Management Studio (SSMS)**

    a. Expand **Databases**

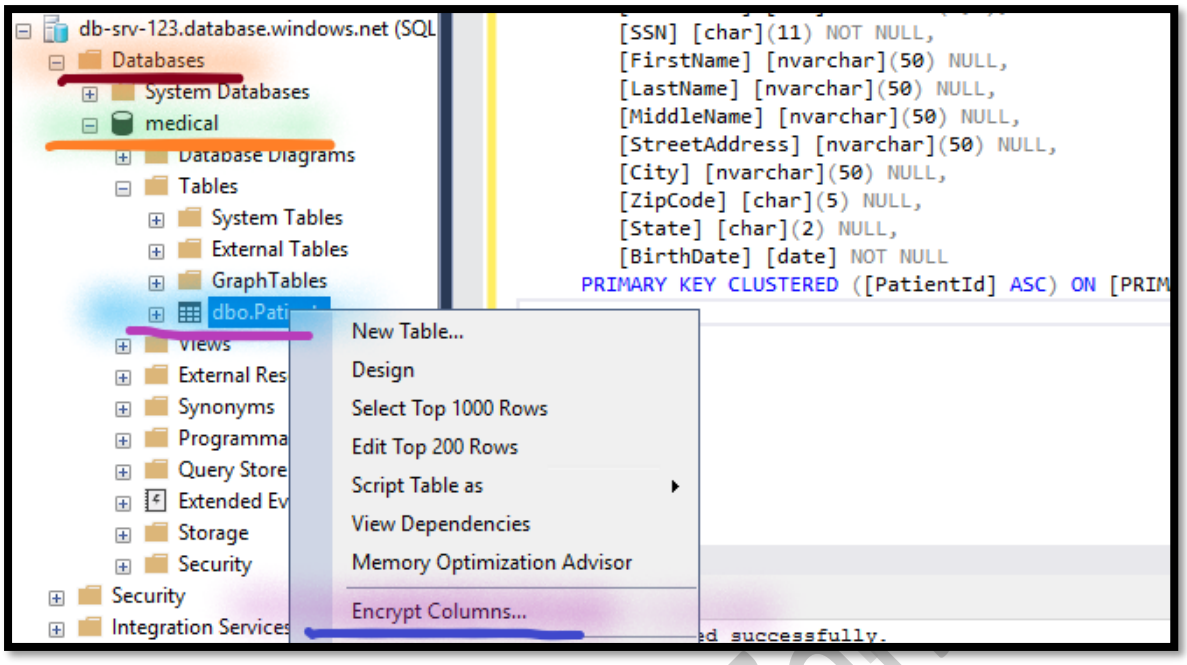
    b. Select **medical** database

    c. Expand **Tables**

    d. **Right click** on **dbo.Patients** tables.

    e. Select **Encrypt columns**.

Note: This will initiate the **Always Encrypted** wizard displays.



i. On the **Introduction page**, click **Next**.

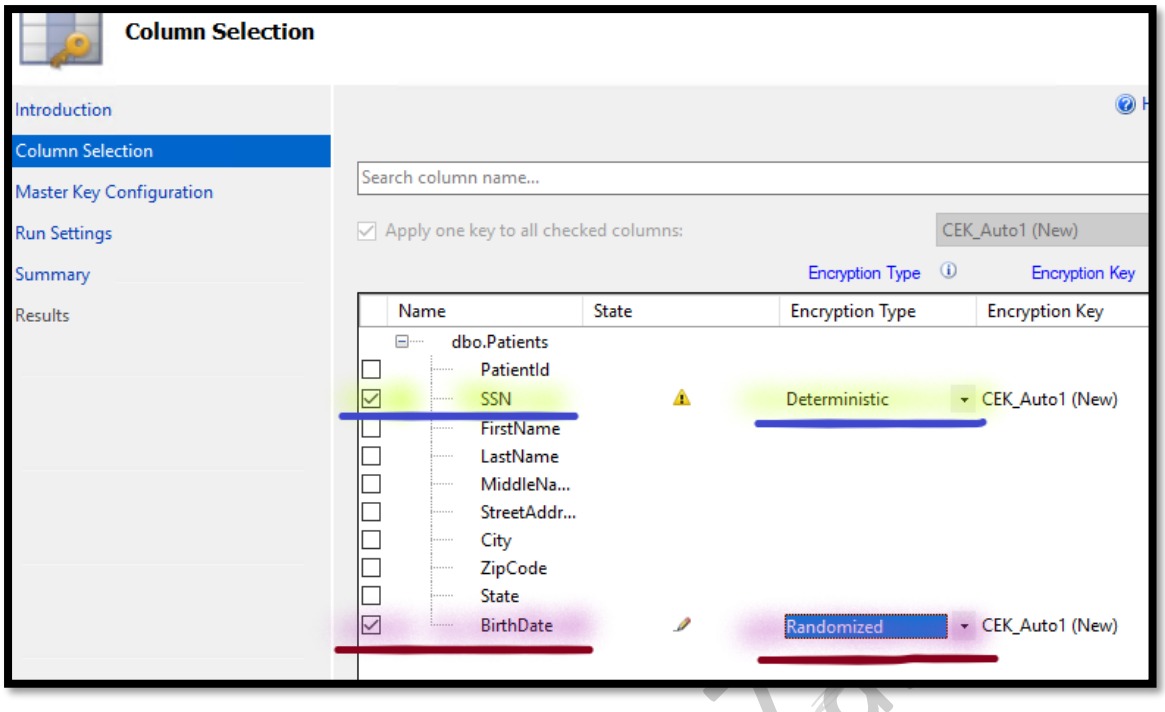
ii. On the **Column Selection page**:

- **Name**: Select the **SSN**.
- **Encryption type**: Dropdown and Select **Deterministic**.

Info: Deterministic Encryption always generates the same encrypted value for any given plaintext value.

- **Name**: Select the **Birthdate**.
- **Encryption type**: Dropdown and Select **Randomized**.

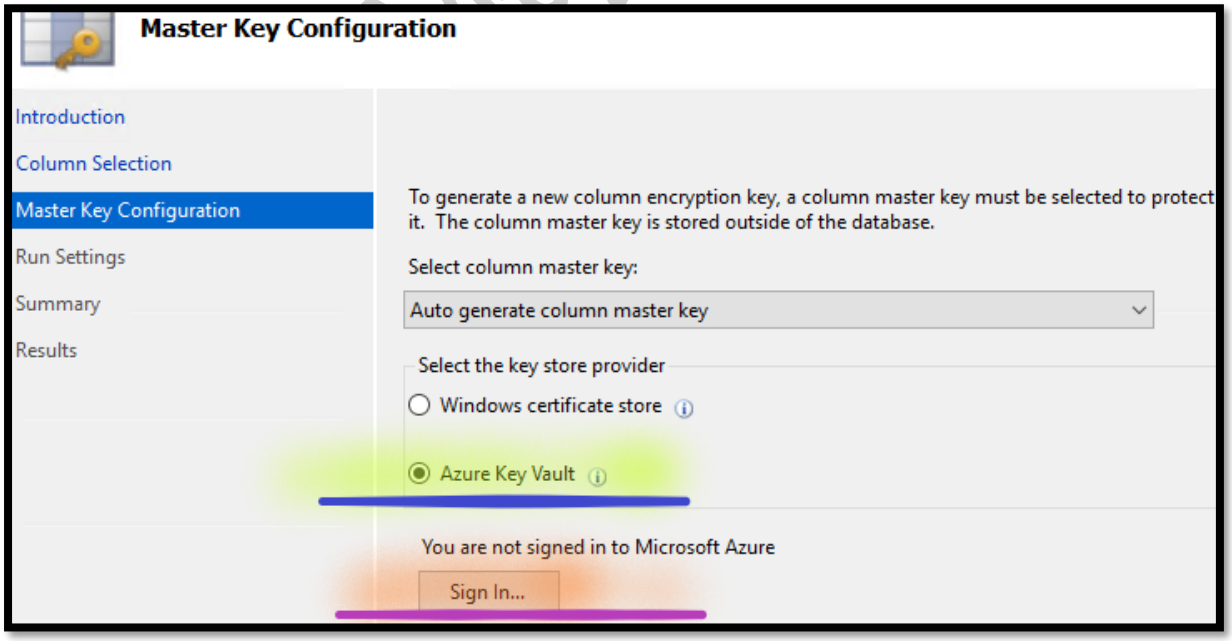
Info: Randomized encryption generates a different encrypted value for the same plaintext each time.



- Click **Next**.

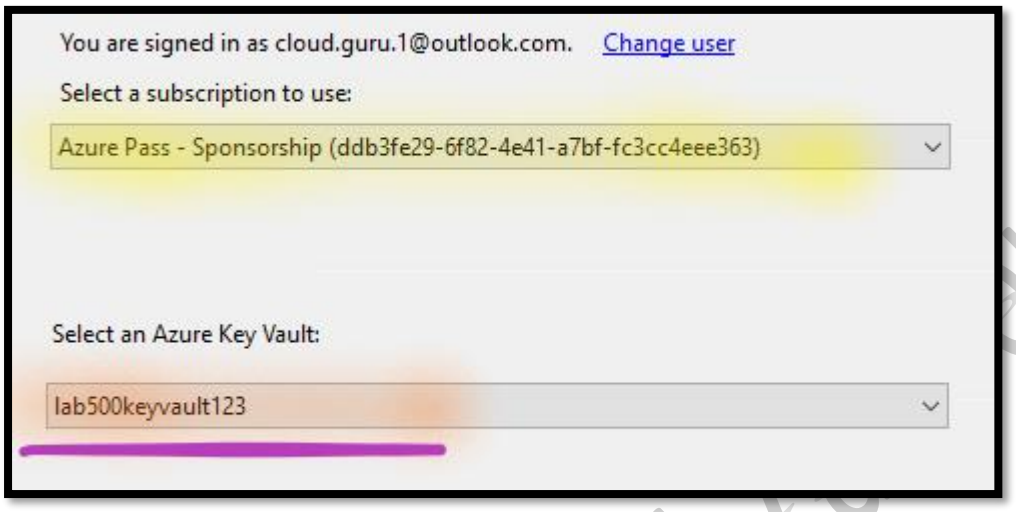
iii. On the **Master Key Configuration page**:

- Select **Azure Key Vault**.
- Click **Sign-in**.



Note: When prompted, authenticate by using the **Azure Root account**.

- **Select a Subscription to use**: Dropdown and Select **your default subscription**.
- **Select an Azure Key Vault**: Dropdown and Select **lab500keyvault123** Key Vault.



- Click **Next**.

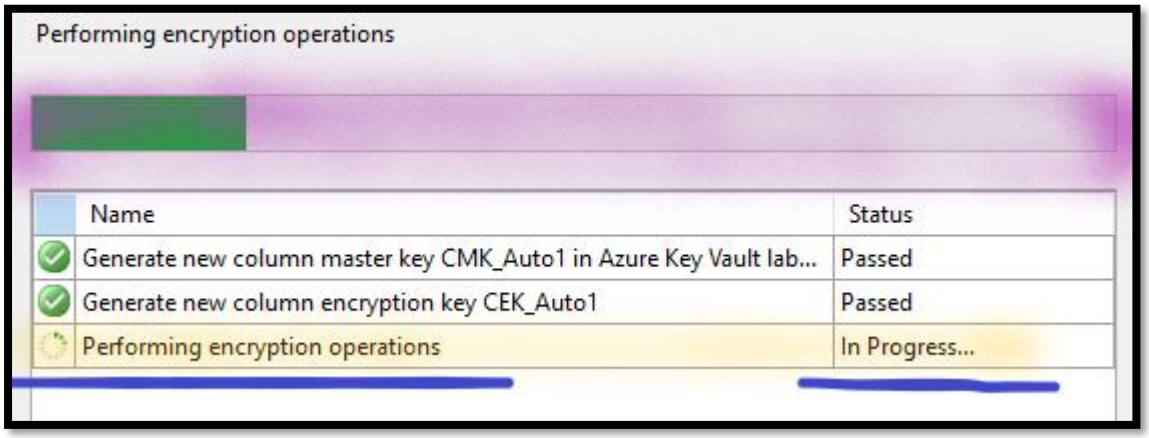
iv. On the **Run Settings page**:

- Click **Next**.

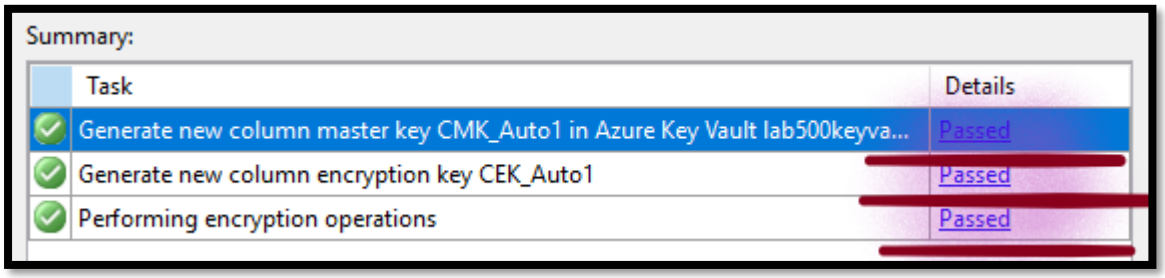
v. On the **Summary page**:

- Click **Finish**.

Note: To proceed with the encryption, when prompted, authenticate by using the **Azure Root account**.



Note: **Wait** till encryption process is complete.



vi. Click **Close**

Step 10: Verify the Encryption

73. From the **SQL Management Studio (SSMS)**

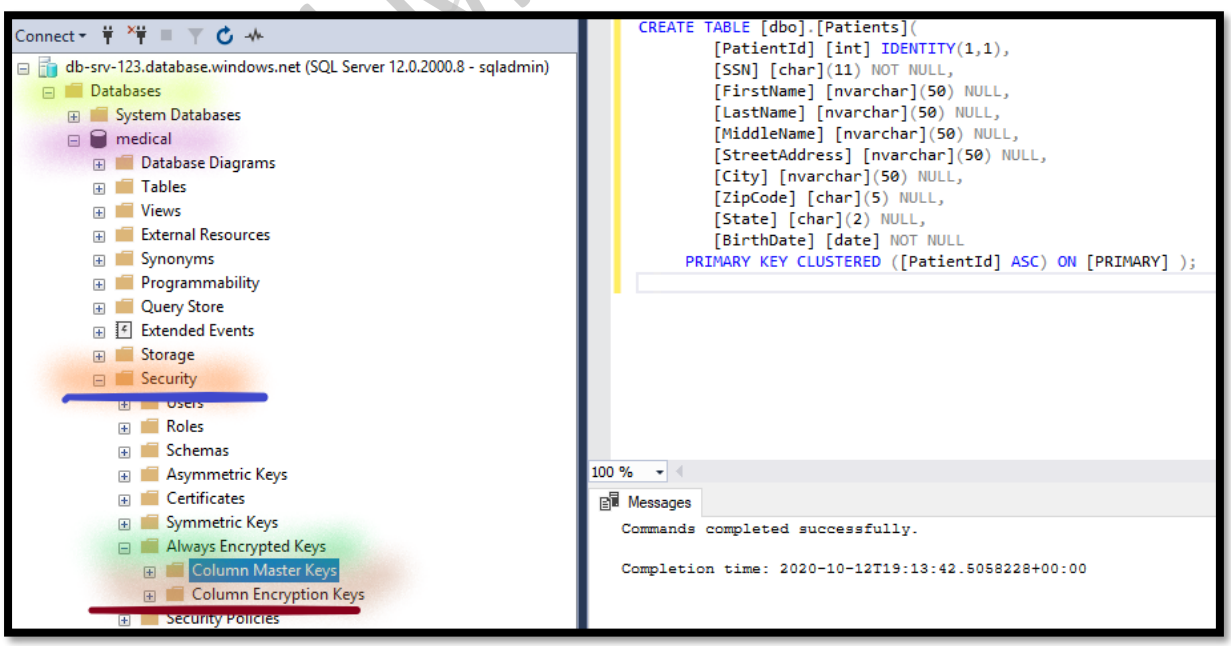
a. Expand **Databases**

b. Select **medical** database

c. Expand **Security**

d. Expand **Always encrypted keys**.

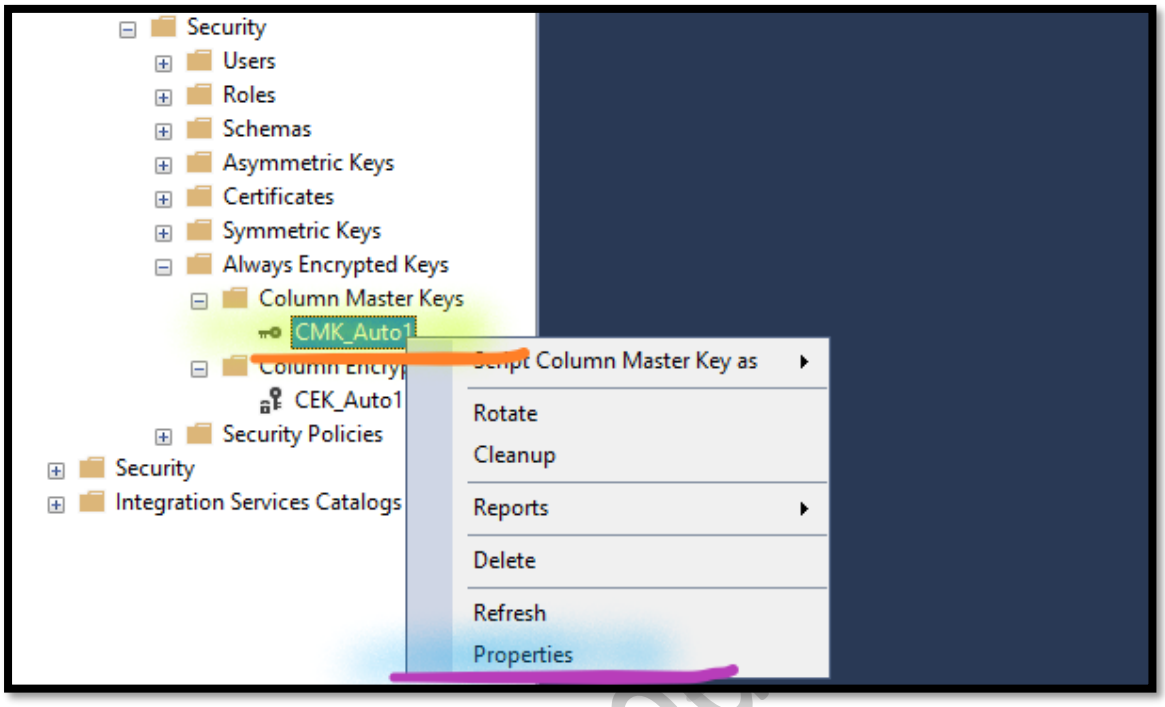
Note: The Always Encrypted Keys subnode contains the Column Master Keys and Column Encryption Keys subfolders.



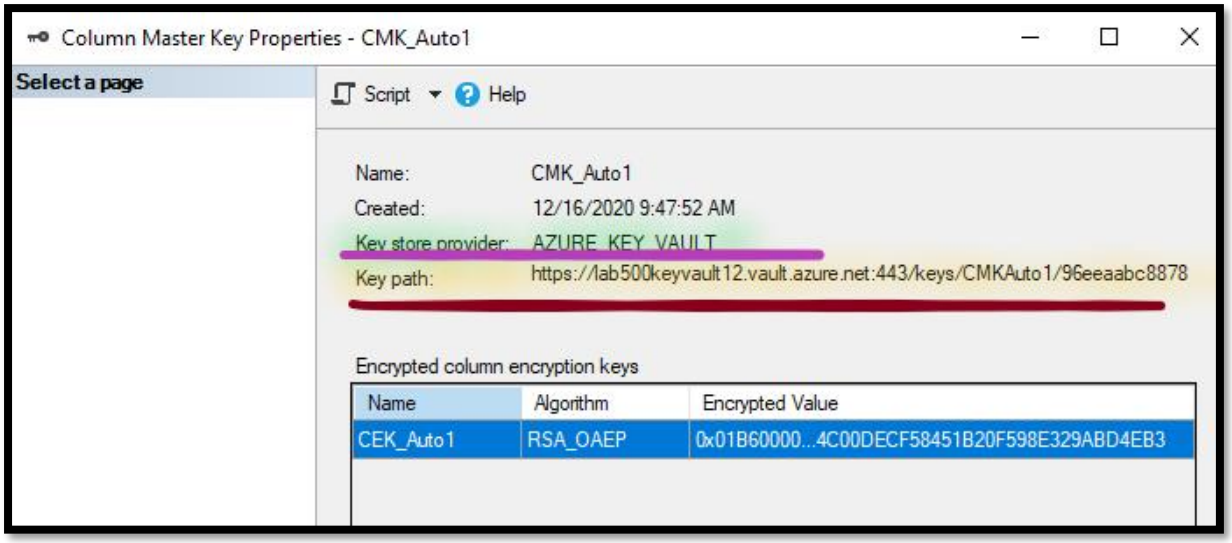
e. Expand **Column Master Keys**.

i. **Right-click** on **CMK_Auto1** key.

ii. Select **Properties.**



Note: You can see the Key path is Azure key Vaults.



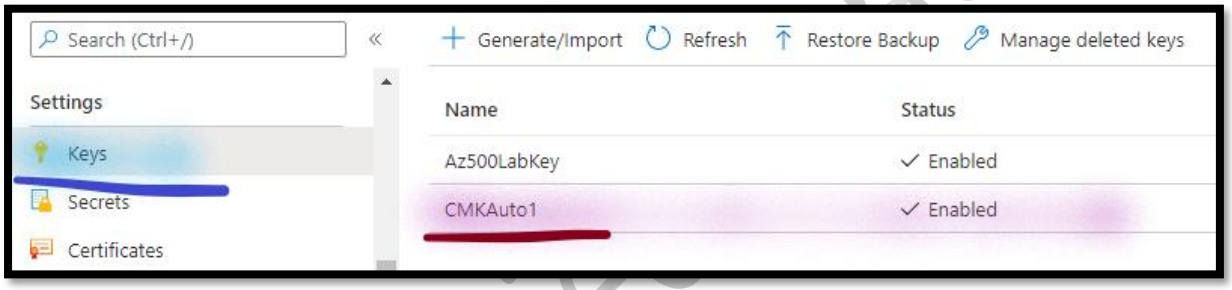
Info: A Column Encryption Key is used to protect and encrypt data in a column. A Column Master Key is used to protect the (one or more) column encryption keys. The information about the Column Master Key is stored in external key stores like Azure Key Vault.

Note: Minimize the SQL Server Management Studio. Don't close the SSMS Console.

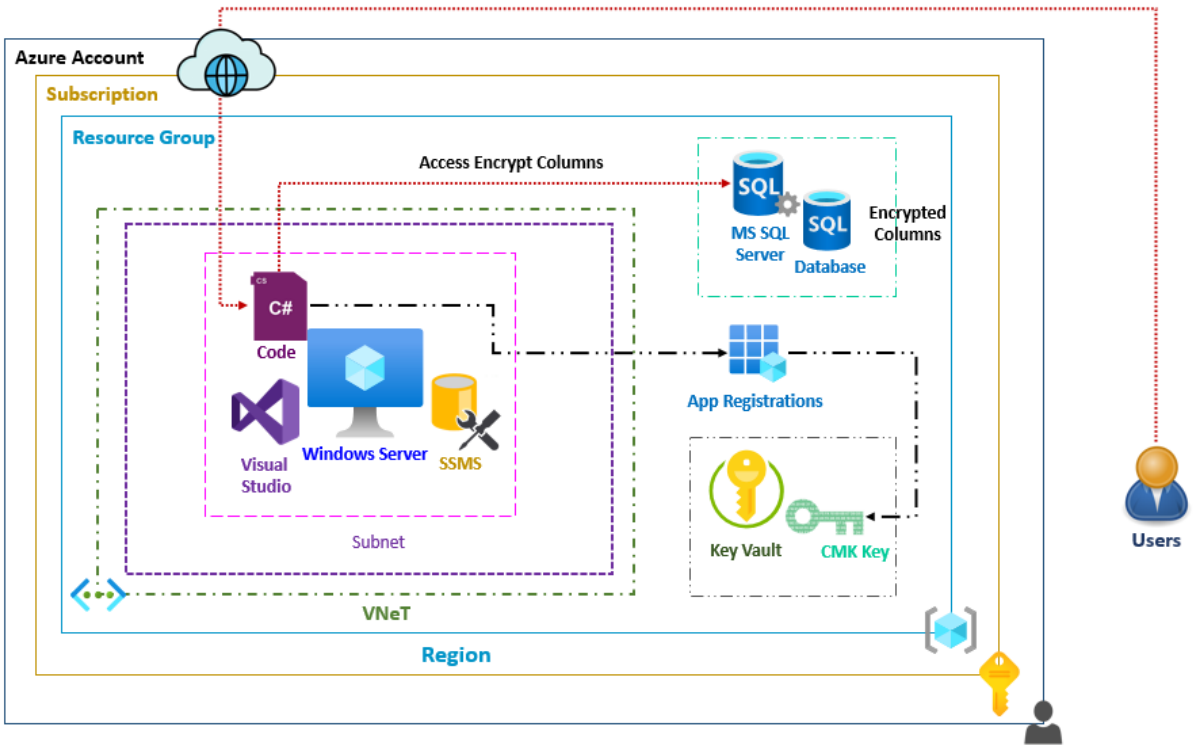
Step 11: View the CMK Key

74. From the **Azure Portal**, go to the left menu, select **resource group**
75. Open resource group **Az-204-13-01-RG**
76. Open Key Vault **lab204keyvault123**
77. Select **Keys** under **settings**

Note: You can see the CMKAuto1 key.

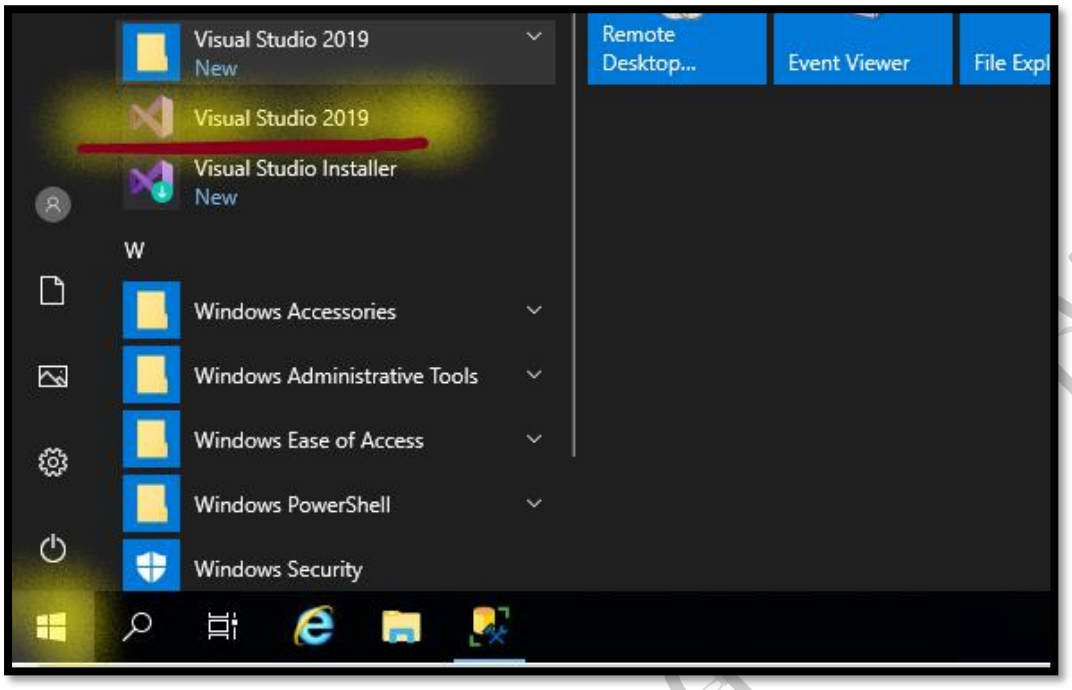


Task 5: Access Encrypted Columns

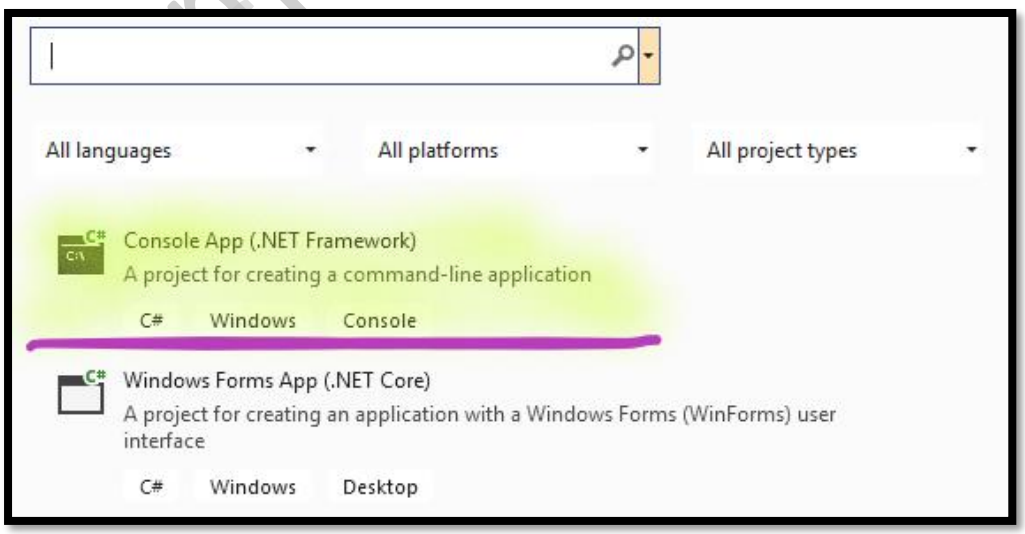


Step 1: Access Encrypted Columns from Application

78. From the **az204-13-vm** virtual machine, Open **Visual Studio 2019**.



79. In the Welcome message, select "**Not now, may be later**".
80. Select **Start Visual Studio**
81. On the **Get started page**:
    a. Click **Create a new project**.
    b. In the list of **Project templates**:
        i. Search for **Console App (.NET Framework)**.
        ii. Click **Console App (.NET Framework)** for **C#**.



iii. Click **Next**.

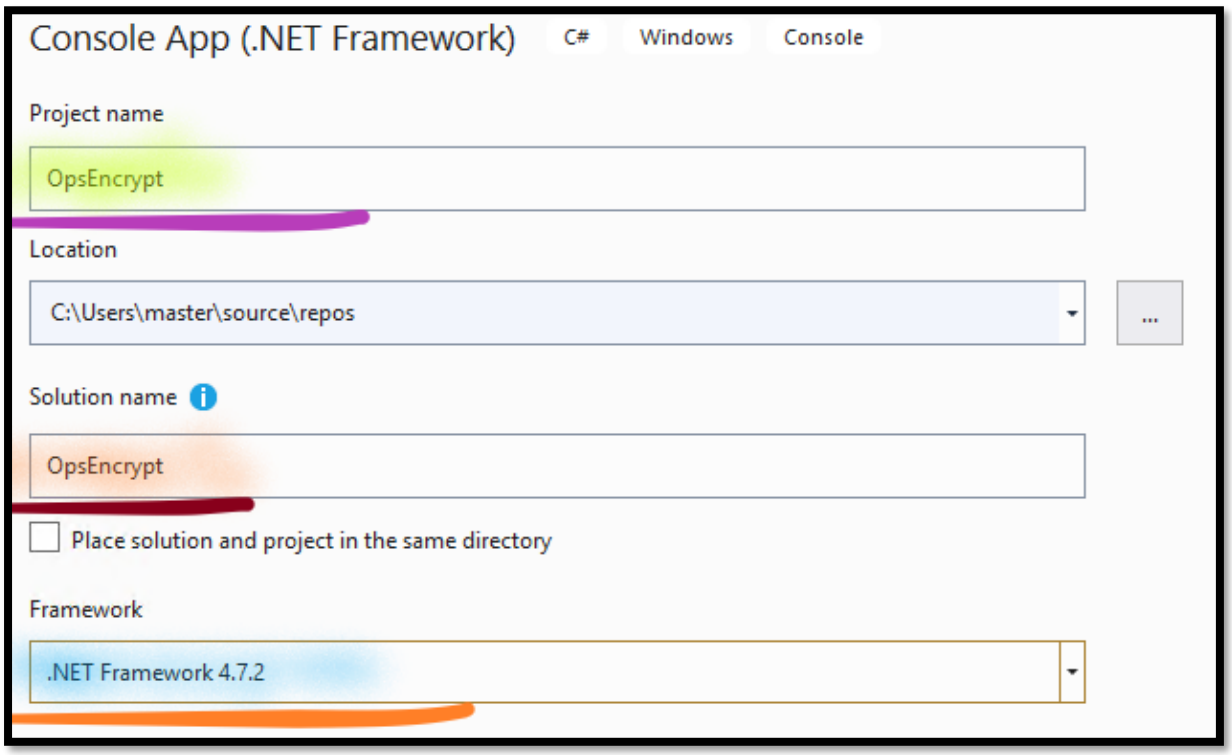
Note: If you missed to install **.NET desktop development** workload, then open Visual Studio, Select Tools and Select Get Tools and Features to install it.

82. On the **Configure your new project page**:

a. **Specify** the following settings:

- **Project name**: Write **OpsEncrypt**.
- **Solution name**: Write **OpsEncrypt**.
- **Framework**: Dropdown and Select **.NET Framework 4.7.2**.

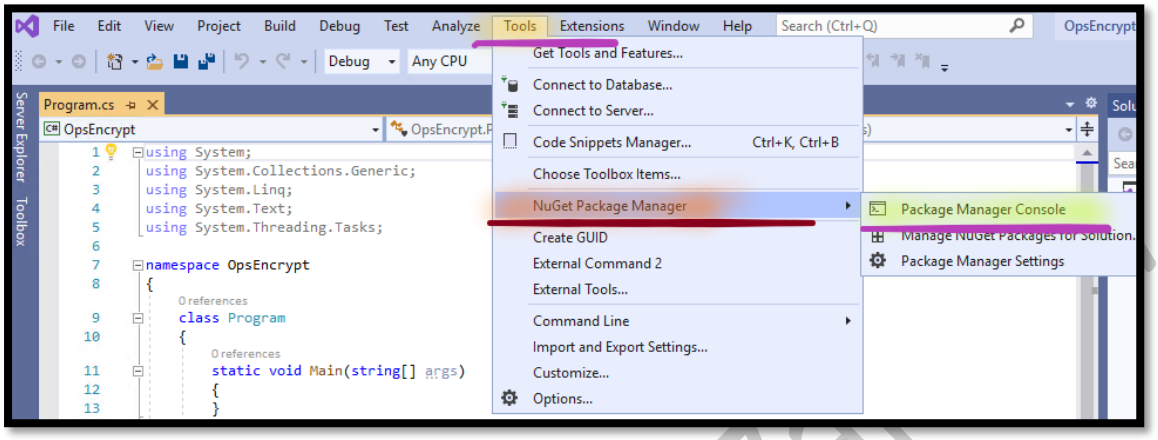
Note: Leave other settings as default.



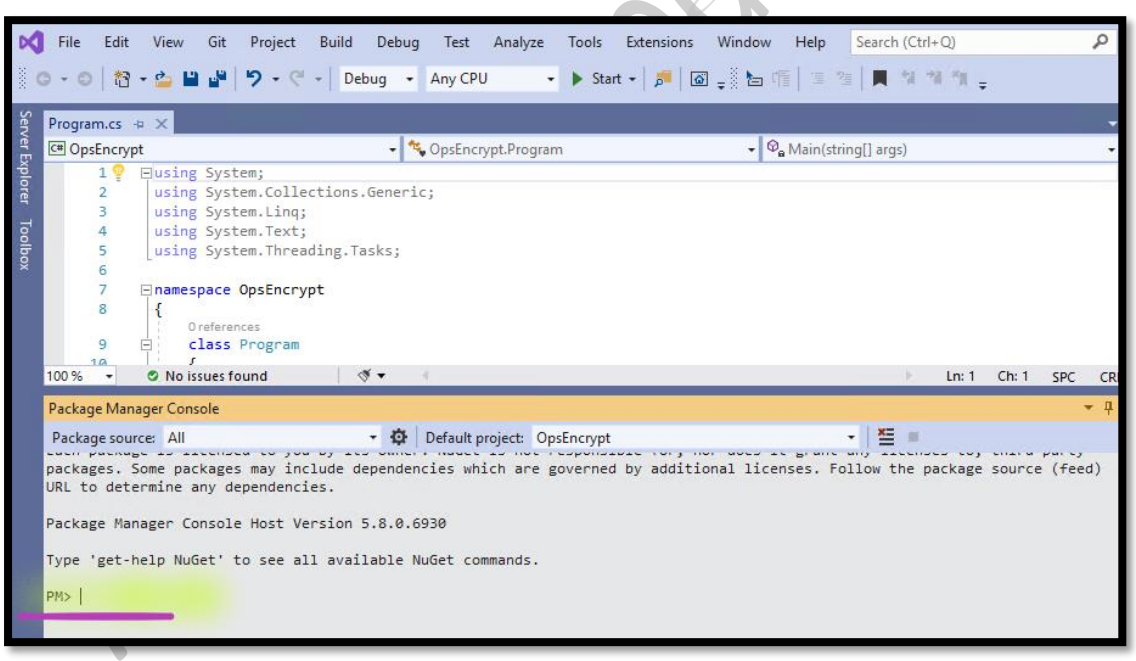
- Select **Create**.

Note: **Wait**, unless Project gets created.

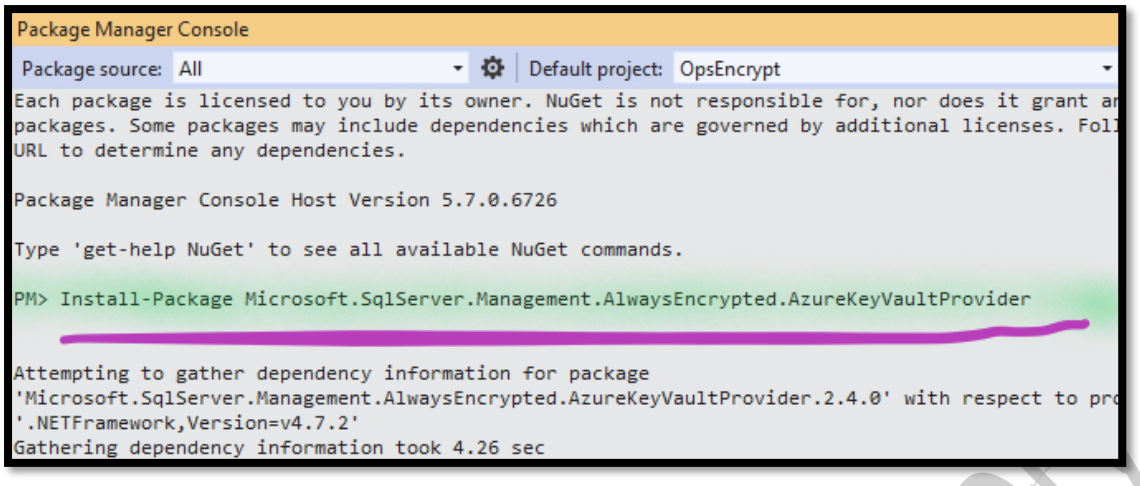
83. In the **Visual Studio console**:
    a. Click the **Tools menu**.
    b. Click **NuGet Package Manager**.
    c. Click **Package Manager Console**.



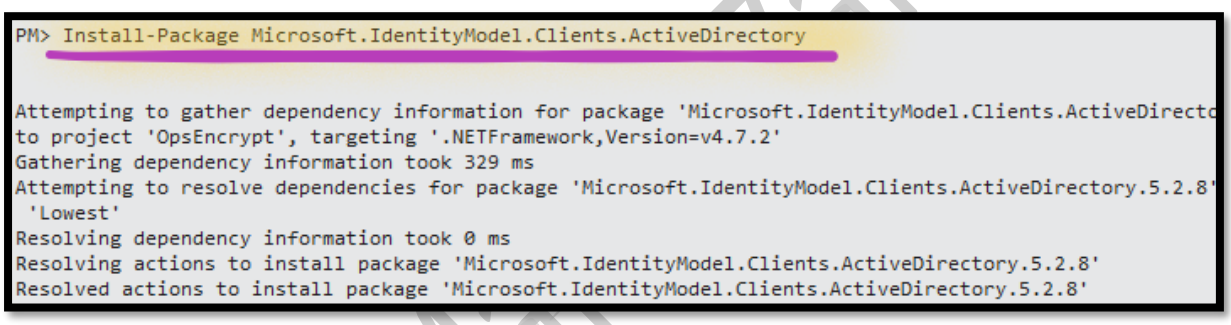
84. In the **Package Manager Console** pane, **run** the following one by one to install the required NuGet packages:




```
Install-Package Microsoft.SqlServer.Management.AlwaysEncrypted.AzureKeyVaultProvider
```




```
Install-Package Microsoft.IdentityModel.Clients.ActiveDirectory
```



85. Open the **program.cs** file in **Notepad**.

Note: **Program.cs** is provided with the Lab Manual.

a. **Replace** the **<connection string noted earlier>** placeholder with the Azure SQL database **ADO.NET** connection string **you copied in the previous step**.

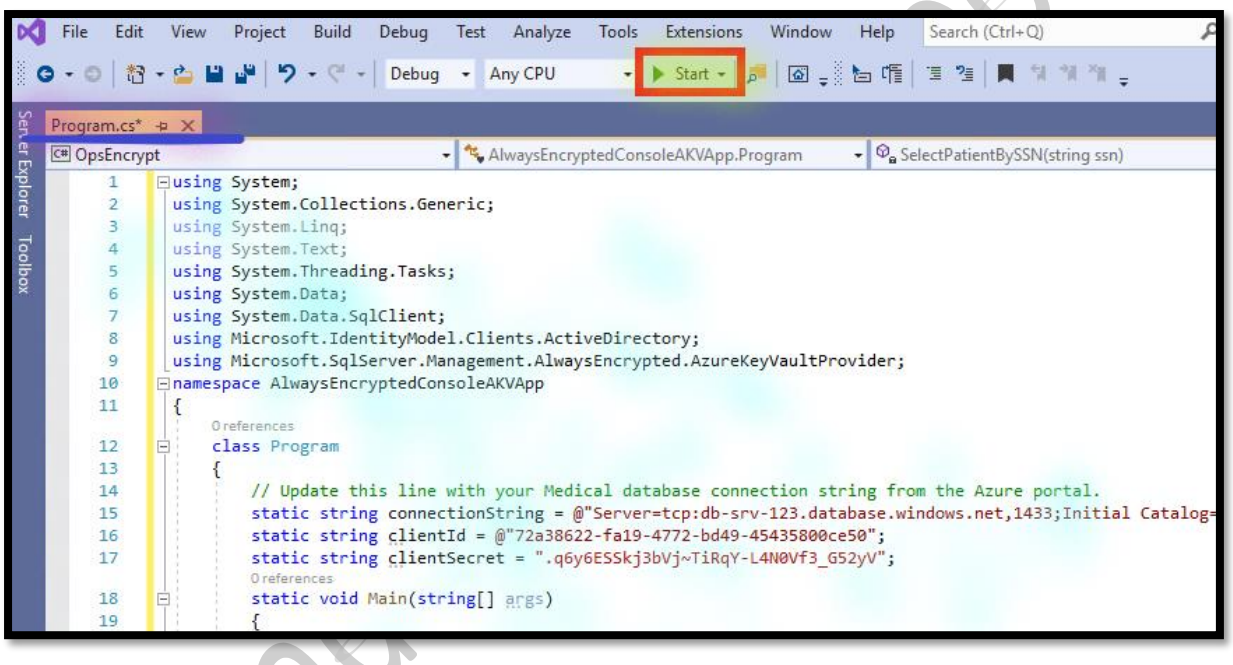
b. **Replace** the **<client id noted earlier>** placeholder with the value of **Application (client) ID** of the registered **app you copied in the previous step**.

c. **Replace** the **<key value noted earlier>** placeholder with the value of **Key1** of the registered app **you copied in the previous step**.

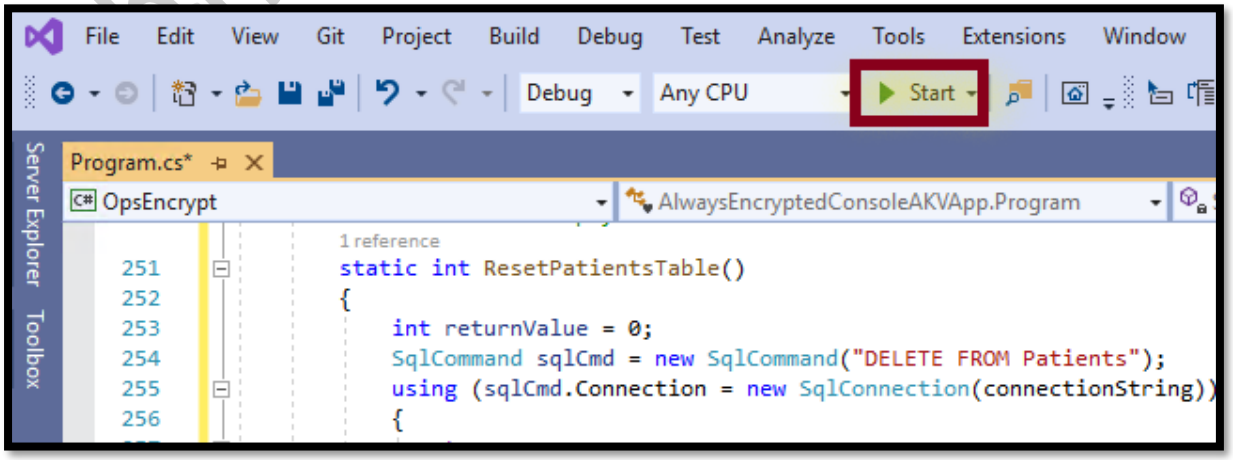
d. **Save** the **program.cs** file

Note: **Don't replace** the start and end quote **" "**.

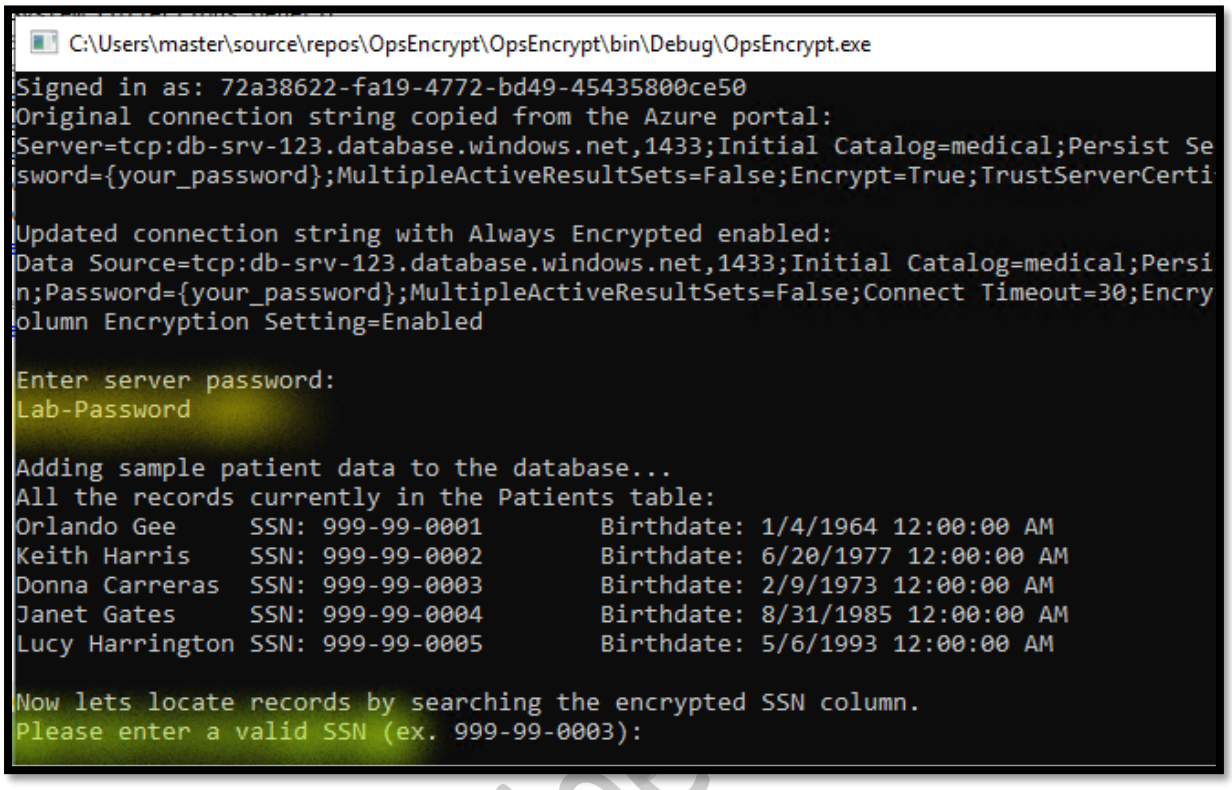
86. From the Visual Studio console, in the **Program.cs**, **replace** its content with the code.



87. Click the **Start**, **Start** button to **initiate the build** of the console application and start it.



88. The application will start a Command Prompt window. When **prompted** for password, write **Lab-Password** to connect to Azure SQL Database.



Step 2: Access the Data Securely

89. **Switch** to the SQL Management Studio console.

90. From the **SQL Management Studio (SSMS)**

    a. Expand **Databases**

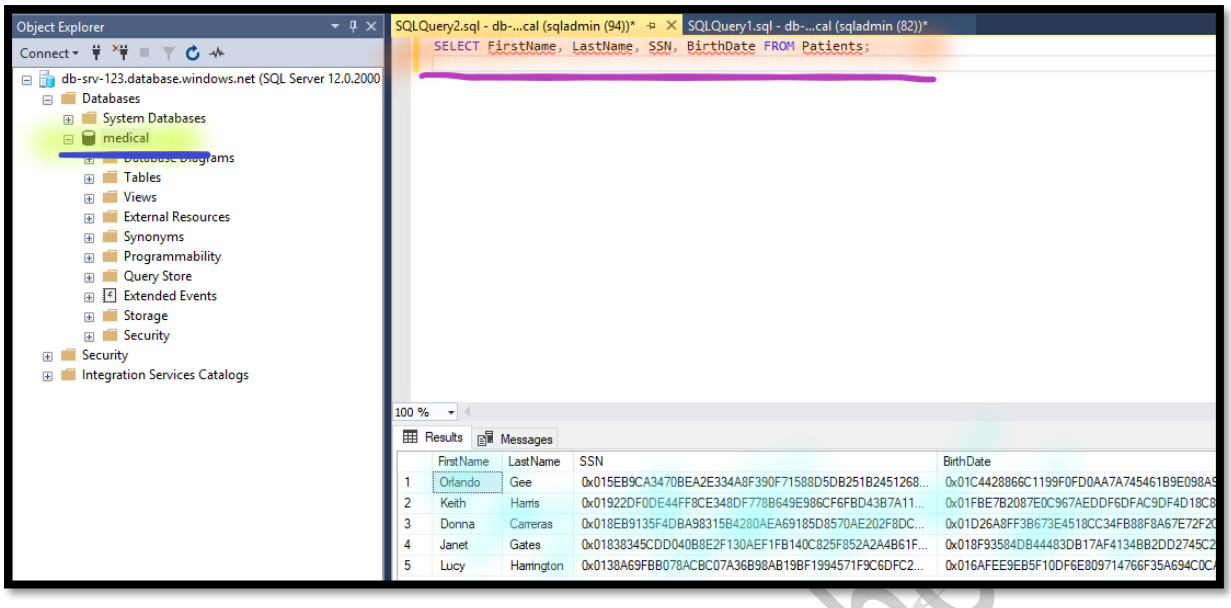
    b. **Right-click** the **medical** database

    c. Click **New query**

    d. **Copy** the below query to verify that the data that loaded into the database from the console app is encrypted.

```
SELECT FirstName, LastName, SSN, BirthDate FROM Patients;
```

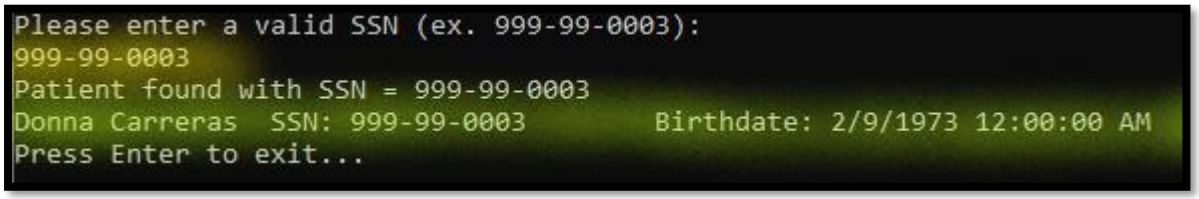
    e. Click **Execute**



Note: You can see the Encrypted, SSN and BirthDate data.

91. **Switch** back to the console application where you are prompted to enter a valid SSN. This will query the encrypted column for the data. At the **Command Prompt**, copy the following and press the Enter key:

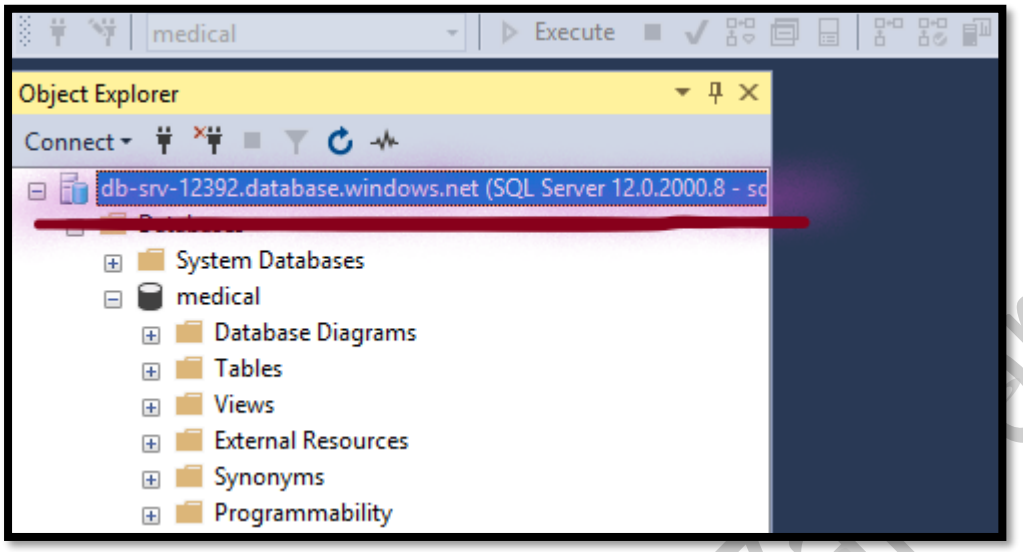
```
999-99-0003
```



Note: Verify that the data returned by the query is not encrypted.

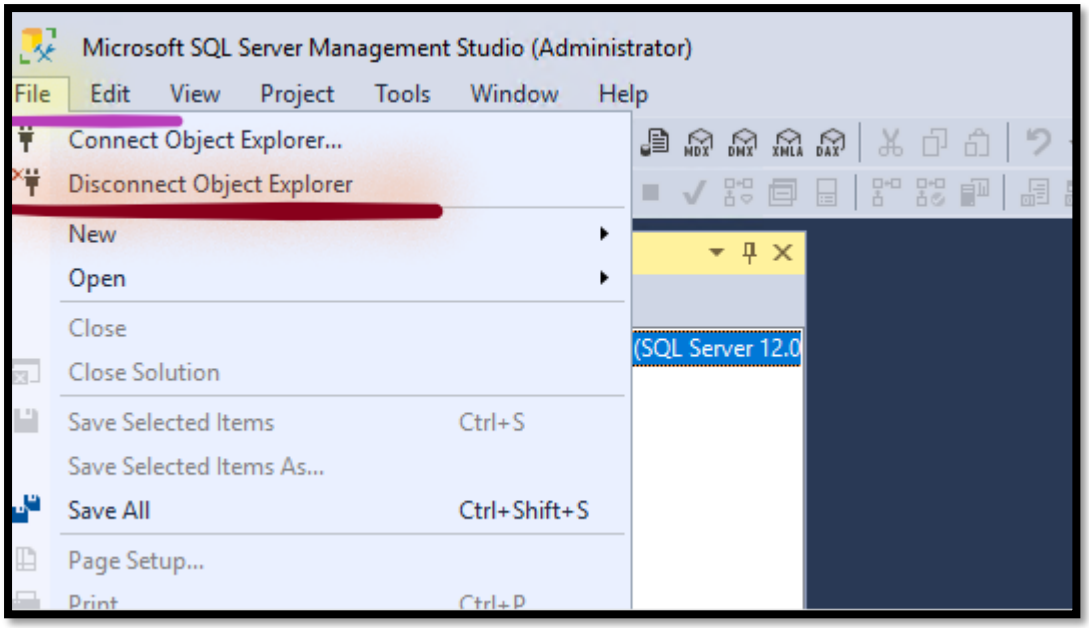
Step 3: Disconnect SQL Database

92.Select **SQL Server** from the **SQL Management Studio console**.



93.Select **File** from the **SQL Management Studio console**.

94.Select **Disconnect object explorer**



Task 6: Delete Environment

Step 1: Delete Resource Group

1. Delete **Az-204-13-01-RG** resource groups