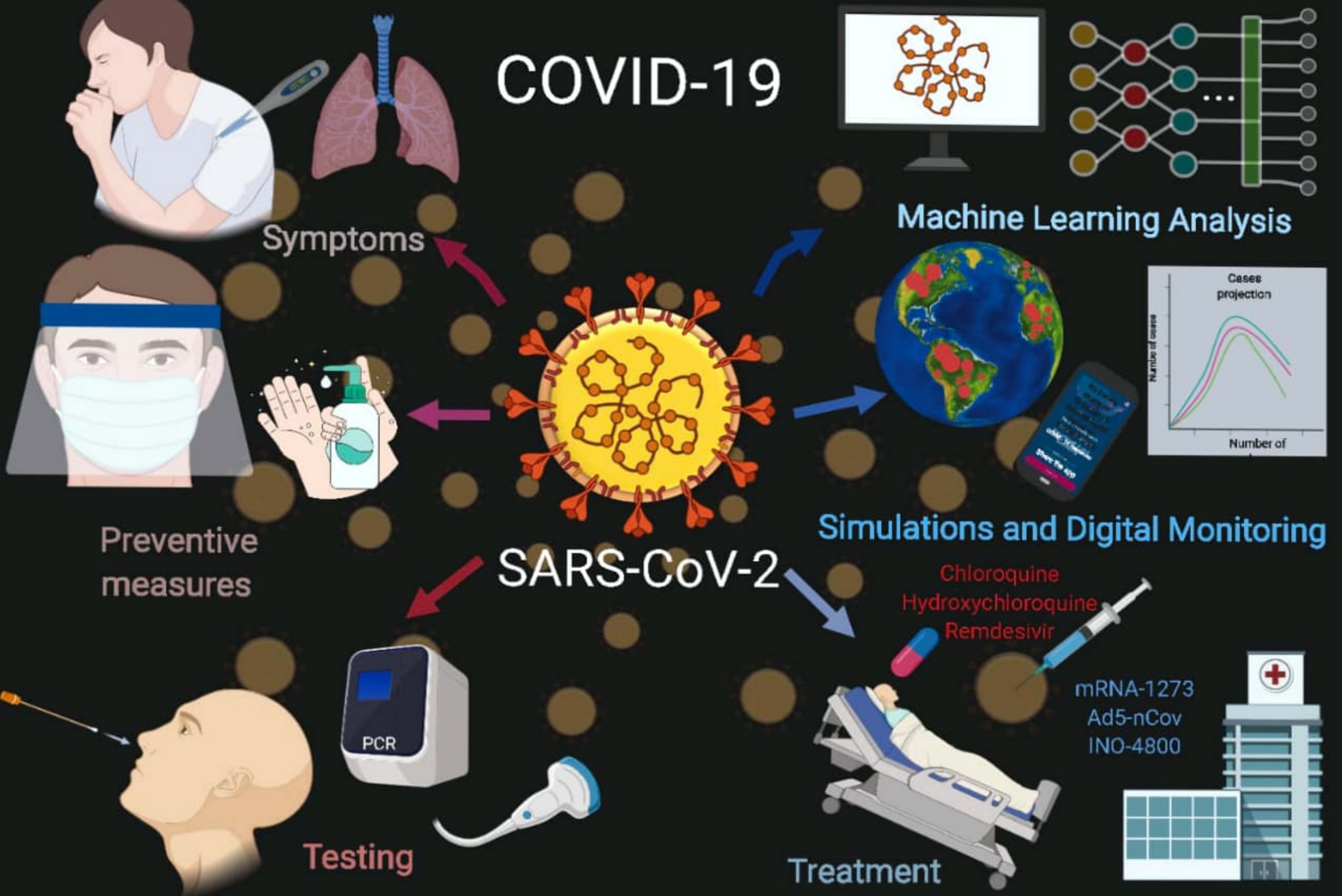## 1. Introduction
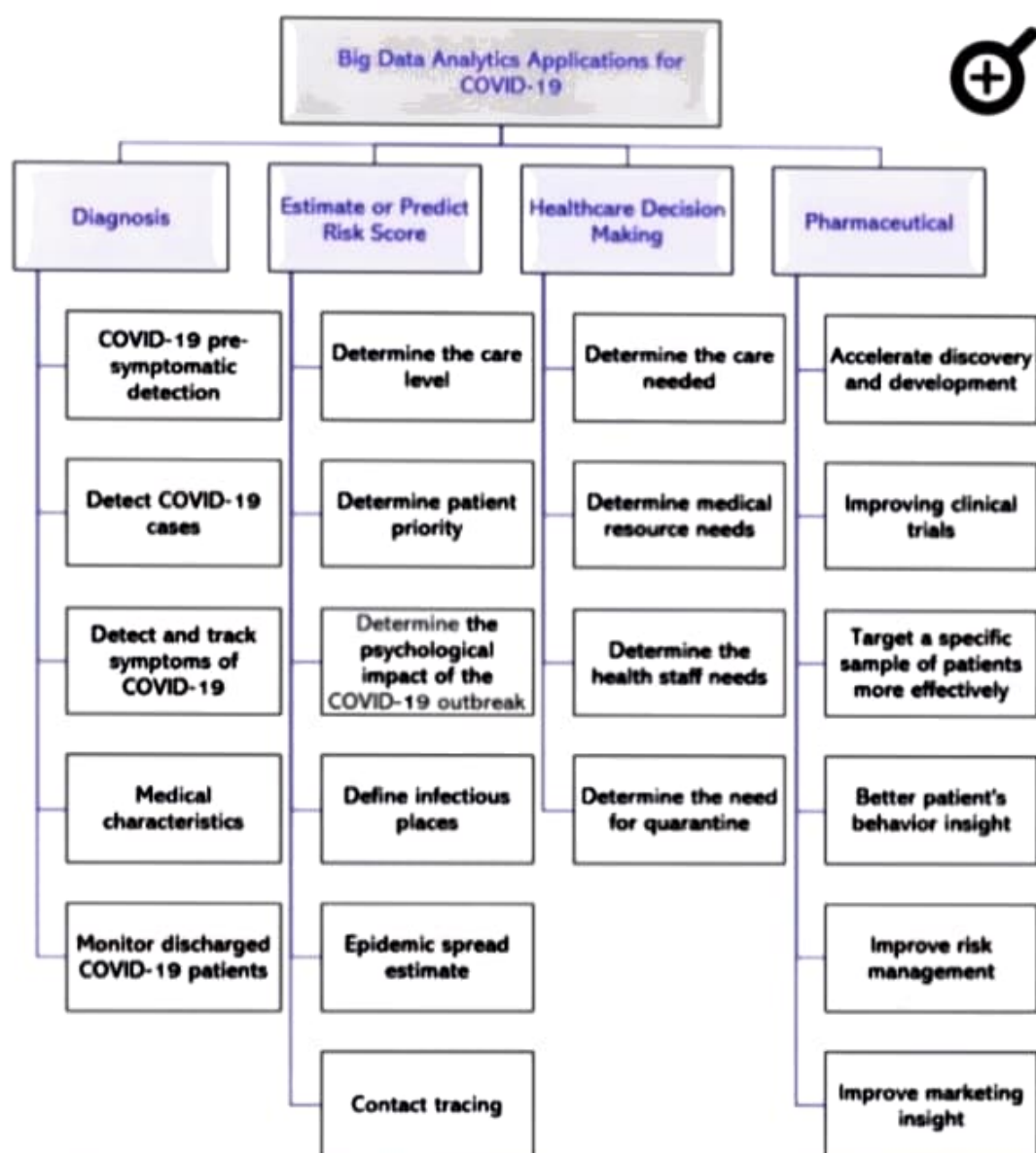
On 30 January 2020, the World Health Organization (WHO) declared the spread of the COVID-19 pandemic as a cause of concern and called for raising the level of health emergencies. Afterward, the government of the Kingdom of Saudi Arabia urgently took several strict measures to limit the spread of the pandemic within the regions of Saudi Arabia [1,2]. The Saudi Ministry of Health (MoH) and many other countries have implemented WHO recommendations related to the identification and isolation of suspected COVID-19 cases.

The spread of the global pandemic, COVID-19, has generated a huge and varied amount of data, which is increasing rapidly. This data can be used by applying big data analytics techniques in multiple areas, including diagnosis, estimate or predict risk score, healthcare decision-making, and pharmaceutical industry . Figure 1 shows examples of potential application areas.

Big Data Analytics Applications for COVID-19			
Diagnosis	**Estimate or Predict Risk Score**	**Healthcare Decision Making**	**Pharmaceutical**
COVID-19 pre-symptomatic detection	Determine the care level	Determine the care needed	Accelerate discovery and development
Detect COVID-19 cases	Determine patient priority	Determine medical resource needs	Improving clinical trials
Detect and track symptoms of COVID-19	Determine the psychological impact of the COVID-19 outbreak	Determine the health staff needs	Target a specific sample of patients more effectively
Medical characteristics	Define infectious places	Determine the need for quarantine	Better patient's behavior insight
Monitor discharged COVID-19 patients	Epidemic spread estimate		Improve risk management
	Contact tracing		Improve marketing insight

2.1. Diagnosis

Suspected COVID-19 cases are diagnosed using the Reverse Transcription-Polymerase Chain Reaction (RT-PCR) test. This test takes around 24 h to several days, depending on the multiple conditions. Many countries experienced increased demand for diagnosing suspected COVID-19 cases, which exceeded the available local testing capacity. Therefore, several researchers have proposed alternative solutions for the COVID-19 RT-PCR diagnosis test, including the following.

The authors in Reference [39] have proposed a model to differentiate between COVID-19 and four other viral chest diseases. The model utilizes several body sensors to collect information and monitor the patient's health condition, including temperature, blood pressure, heart rate, respiratory monitoring, glucose detection, and others. The collected data is stored on a cloud database containing AI-enabled expert systems that help diagnose symptoms of patients infected or suspected of having COVID-19 to determine the appropriate procedure to deal with them. ·

In Reference [40], the authors provided a flexible and low-cost design of a medical device that can be used to detect and track symptoms of COVID-19. It utilizes headphones and a mobile phone to detect breathing problems. The signals are collected and saved in an audio file format through the mobile app, after which the signals are analyzed using the MATLAB program to identify the respiratory symptoms associated with COVID-19.

Researchers [41] also developed a program to remotely monitor discharged COVID-19 patients. Each patient registered to the app is provided with a pulse oximeter and thermometer to self-report daily symptoms, O2 saturation, and temperature. The abnormal vital signs and symptoms are flagged to be assessed by a group of nurses. Depending on the evaluation outcome, the patient might be readmitted to the Emergency Department (ED). The program helps reduce ED utilization and provides scalable remote monitoring capabilities when a patient is discharged from the hospital.

The outbreak

Etiology

Treatment

Diagnosis

Clinical Features

Virology

Prognosis

Prevention

SARS-COV-2

Revenue

- **Inter-governmental transfers, grants and subsidies**
  - Increase amount of existing block and earmarked grants (operating and investment grants)
  - Provide advance payments on grants
  - Establish emergency grants to cope with specific needs
  - Reorganise inter-governmental transfers systems
- **Tax revenues and non-tax revenues**
  - Shared taxation: increasing subnational shares of national taxes; anticipated transfers of shared taxes receipts
  - Own-source taxation: transferring or establishing new taxes; providing greater taxing power to SNGs
  - Increasing non-tax revenues
- **Compensation schemes:**
  - Provide temporary compensations for the loss of taxes and fees revenues
- **Rainy day funds / fiscal reserves**
- **Equalisation mechanisms**
  - Activate local conjunctural equalisation funds
  - Adapt equalisation formula to take into account the specificities of the crisis

Expenditure

- **Spending responsibilities**
  - Ease spending responsibilities
  - Transfer spending responsibilities to the central government temporarily
  - Redefine the strategic assignment of responsibilities to SNGs in the medium term
  - Secure investment expenditure
- **Reduce temporarily SNGs employer's contributions**
- **Exempt temporarily SNGs for tax payment**
  - Eg VAT exemptions for the purchase of material to combat the pandemic
- **Adapt public procurement procedures**
  - Eg for the purchase of material to combat the pandemic
  - **Help local governments in finding savings and efficiency**

Fiscal rules & debt

- **Relax or suspend budget rules on:**
  - Current and investment expenditures
  - Budget balance and excessive deficit
- **Debt management and borrowing**
  - Relax prudential rules and caps on debt stock and debt service, prior authorisation, etc.
  - Suspend / cancel / renegotiate loans payments
  - Set up debt relief programmes for highly indebted SNGs
  - Ease access to short-term credit lines and liquidity advances, including specific COVID-19 credit lines
  - Ease access to long-term term borrowing including by facilitating the access to capital markets and establishing COVID-19 bonds
  - Provide loans guarantees to SNGs and assist local governments in arranging low-interest rate loans
  - Provide low-cost public loans
  - Central banks intervention on financial markets (liquidity facility)

Financial management

- **Budgeting and accounting**
  - Adapt budgeting and accounting frameworks to manage the crisis
  - Set up special COVID-19 accounts
  - Loosen reporting requirements
  - Introduce multi-annual budgeting practices
- **E-financial management:** encourage the use of e-government tools in financial decision and management
- **Develop prospective financial analysis and fiscal sustainability/resilience plans at subnational level**
- Help SNGs fight against fraud, recover unpaid taxes
- **Loosen regulation to enter into contracts**
- **Introduce more flexibility in staff management**
- **Support local public companies**