# Tab: Data at admission

Total no. of patients = 508

1. Average Age: 66.02
2. Max Age: 100
3. Min Age: 19
4. Sex: Male = 296 / Female = 212
5. ​​Ethnicity: Blank
6. Ethnicity Other: Blank
7. Height: 236(Blank)
8. Average Height: 166.91 (272 Patients)
9. Weight: 150(Blank)
10. Average Weight: 80.26
11. Comorbidities: 18 (Unique) and 50 (Blank)

Comorbidities Frequencies:

* Other: 400
* Hypertension: 310
* Diabetes: 175
* Chronic cardiac disease (not hypertension): 88

1. Comorbidities\_other: 404 (Blank: 104)
2. Received\_covid\_vaccine: Just 1 data point available
3. Covid\_vaccine: Blank
4. Medications: 693 Unique Medications
5. Unique Medications Frequencies:

| OD | 1920 |
| --- | --- |
| null | 2 |
| QUID | 68 |
| PRN | 149 |
| Weekly | 33 |
| Please Select an option | 147 |
| TID | 101 |
| BID | 463 |
| 0 | 0 |
| Every Other Day | 9 |

1. Smoking\_history: 296 Given (Blank: 212)

Smoking\_history types:

* Ex-smoker
* Smoker: pack years unknown
* Non-smoker
* Smoker: < 30 pack years

1. The year they quit: 43 available (Blank: 465)
2. Previous\_er\_visit\_within\_14\_days: 401 = No / 107 = Yes
3. No of people admitted in the ward = 465
4. No of people admitted to the ICU = 43
5. Intubated: 15 = Yes / 493 = No

**Systolic\_blood\_pressure, diastolic\_blood\_pressure, heart\_rate, respiratory\_rate, oxygen\_saturation, temperature, motor, verbal eye, wbc, rbc, hemoglobin, hematocrit, mcv, mch, mchc, rdw, platelet\_count, aptt\_aptr, pt, alt, ast, serum\_creatinine, sodium, potassium, total\_serum\_bilirubin, lactate pao2, pao2\_fio2, ph, high\_senstivity\_cardiac\_troponin, esr, inr, ferritin, d\_dimer, crp, hs\_crp = Medical Numerical Numerical Values**

|  |  |
| --- | --- |

1. Fever [R50.9]
2. Pneumonia [J18.9]
3. Suspected COVID-19 virus infection [U07.2]
4. Febrile respiratory illness [J98.9, R50.9]
5. Respiratory failure [J96.99]
6. COVID-19 [U07.1]
7. Pneumonia due to COVID-19 virus [U07.1, J12.8]
8. Cough [R05]
9. Respiratory tract infection [J98.8]
10. Coronavirus infection [B34.2]
11. Shortness of breath [R06.0]
12. Hypoxia [R09.0]
13. Tachypnea [R06.8]
14. Fever of unknown origin [R50.9]
15. Respiratory distress [R06.0]
16. Pneumonia due to 2019-nCoV [U07.1, J12.8]
17. COVID-19 with multiple comorbidities [U07.1]
18. COVID-19 determined by clinical diagnostic criteria [U07.2]
19. Myalgia [M79.19]
20. COVID-19 virus infection [U07.1]
21. ARDS (adult respiratory distress syndrome) [J80]
22. Acquired respiratory distress syndrome [J80]
23. Hypoxemia [R09.0]
24. Viral pneumonia [J12.9]
25. Hypoxic [R09.0]
26. Shortness of breath with exposure to COVID-19 virus [R06.0, U07.2]
27. Atypical pneumonia [J18.9]

## Statistics

27 unique reasons for admission

Max age for patient = 100

Min age for patient = 19

Two admission dispositions:

Ward and ICU

D. Male = 296

Female = 212

P. previous\_er\_visit\_within\_14\_days

Yes = 107

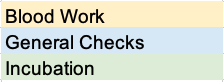
No = 401

Q.

No. of people admitted in Ward VS ICU

No of people admitted in the ward = 465

No of people admitted to the ICU = 43



Number of patients admitted through Covid = 272

Number of patients admitted through Non-Covid = 236

| **Reson for admission** | **#Patients** |
| --- | --- |
| Fever/Pneumonia (Pneumonia, Fever, Viral Pneumonia) | 159 |
| Lack of oxygen | 22 |
| Muscle Pain | 1 |
| Respiratory Problem (Tach, Respiratory DistressFailure/distress/infection/, shortness of breath) | 52 |
| Cough | 2 |
| **Total** | **236** |

Non-Covid ICU = 26

Non-Covid Ward = 210

Given:

1. Patient ID - 252
2. 68yrs
3. Male
4. Admission = ICU
5. ICU LoS = 9 (Includes LoS in ICU before mechanical ventilation = 1)
6. Hospital LoS = 16
7. Expired = No

Assumptions:

1. Ward LoS = 7
2. Patient ID - 6
3. 44 yrs
4. Male
5. Admission = ICU
6. ICU LoS = 25 (Includes LoS in ICU before mechanical ventilation = 1)
7. Hospital LoS = 32
8. Expired = No

Assumptions:

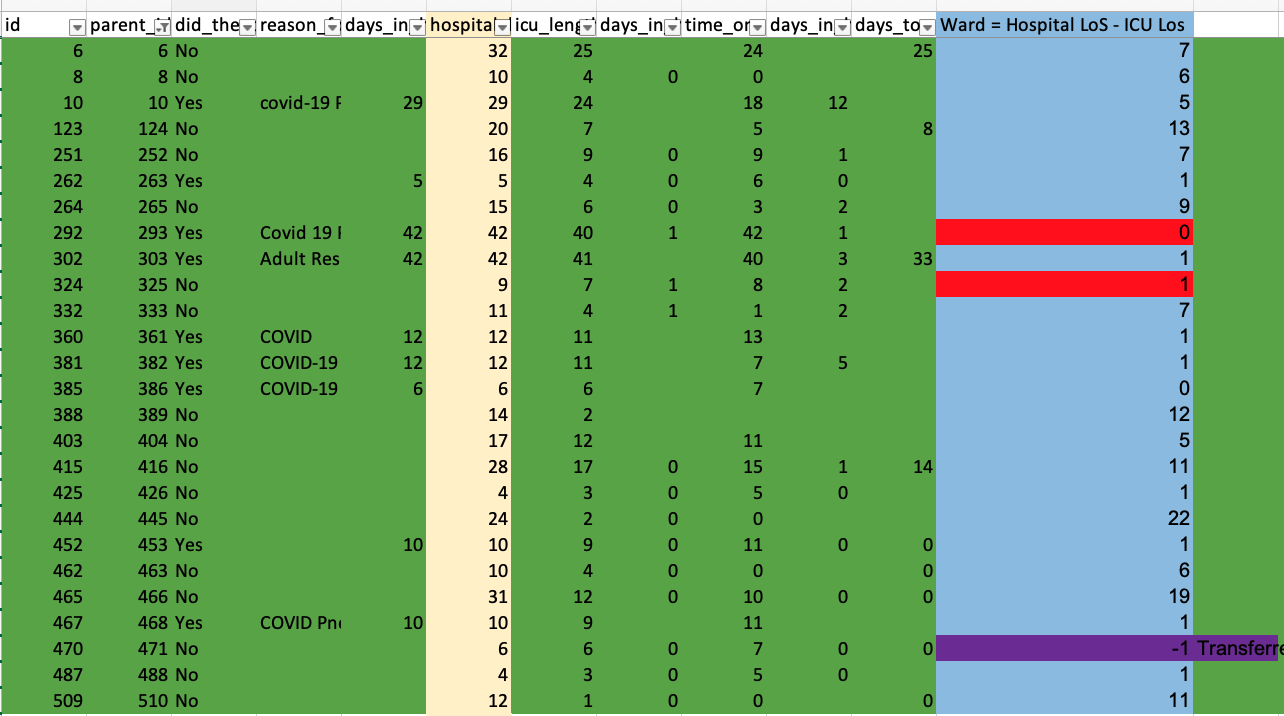
1. Ward LoS = 7

Assumptions:

1. Patient ID - 8
2. 44 yrs
3. Male
4. Admission = ICU
5. ICU LoS = 4 (Includes LoS in ICU before mechanical ventilation = 1)
6. Hospital LoS = 10
7. Expired = No

Assumptions:

1. Ward LoS = 6



### Non-Covid Admitted

Admitted = ICU >> patients who expired >> 9 of them moved from ICU to WARD

| parent\_id | hospital\_length\_of\_stay | icu\_length\_of\_stay | Ward = Hospital LoS - ICU Los |  |
| --- | --- | --- | --- | --- |
| 10 | 29 | 24 | 5 |  |
| 263 | 5 | 4 | 1 |  |
| 293 | 42 | 40 | 0 | Was transferred to Ward maybe? |
| 303 | 42 | 41 | 1 |  |
| 361 | 12 | 11 | 1 |  |
| 382 | 12 | 11 | 1 |  |
| 386 | 6 | 6 | 0 |  |
| 453 | 10 | 9 | 1 |  |
| 468 | 10 | 9 | 1 |  |

Moved from Ward to ICU and vice versa assumed from Incubation:

**Ward to ICU**

Parent ID 10: Day 14 = Moved from Ward to ICU

Parent ID 293: Day 2 = Moved from Ward to ICU (Assumed)

Parent ID 303: Day 3 = Moved from Ward to ICU

Parent ID 382: Day 5 = Moved from Ward to ICU

**ICU to WARD**

Parent ID 382: Day 14 = Moved from ICU to Ward

Parent ID 386: Day 7 = Moved from ICU to Ward

Parent ID 453: Day 14 = Moved from ICU to Ward

Parent ID 468: Day 14 = Moved from ICU to Ward

Parent ID 263: Day 7 = Moved from ICU to Ward

Parent ID 361: Day 14 = Moved from ICU to Ward

Admitted = ICU >> patients who did not expire >> 17 of them moved from ICU to WARD

| parent\_id | did\_the\_patient\_expire\_in\_hospital | hospital\_length\_of\_stay | icu\_length\_of\_stay | Ward = Hospital LoS - ICU Los |  |
| --- | --- | --- | --- | --- | --- |
| 6 | No | 32 | 25 | 7 |  |
| 8 | No | 10 | 4 | 6 |  |
| 124 | No | 20 | 7 | 13 |  |
| 252 | No | 16 | 9 | 7 |  |
| 265 | No | 15 | 6 | 9 |  |
| 325 | No | 9 | 7 | 1 | Was transferred to Ward on the 8th day? |
| 333 | No | 11 | 4 | 7 |  |
| 389 | No | 14 | 2 | 12 |  |
| 404 | No | 17 | 12 | 5 |  |
| 416 | No | 28 | 17 | 11 |  |
| 426 | No | 4 | 3 | 1 |  |
| 445 | No | 24 | 2 | 22 |  |
| 463 | No | 10 | 4 | 6 |  |
| 466 | No | 31 | 12 | 19 |  |
| 471 | No | 6 | 6 | -1 | Transferred from another hospital |
| 488 | No | 4 | 3 | 1 |  |
| 510 | No | 12 | 1 | 11 |  |

Moved from ICU to Ward and vice versa assumed from Incubation:

**Ward to ICU**

Parent ID 325: Day 2 = Moved from Ward to ICU

Parent ID 333: Day 2 = Moved from Ward to ICU

**ICU to WARD**

Parent ID 124: Day 5 = Moved from ICU to Ward

Parent ID 252: Day 14 = Moved from ICU to Ward

Parent ID 265: Day 5 = Moved from ICU to Ward

Parent ID 124: Day 5 = Moved from ICU to Ward

Parent ID 325: Day 14 = Moved from ICU to Ward

Parent ID 333: Day 2 = Moved from ICU to Ward

Parent ID 404: Day 14 = Moved from ICU to Ward

Parent ID 426: Day 5 = Moved from ICU to Ward

Parent ID 466: Day 14 = Moved from ICU to Ward

Parent ID 471: Day 7 = Moved from ICU to Ward

Parent ID 488: Day 5 = Moved from ICU to Ward

Links between Ward and ICU assumed based on the medical examinations they underwent

1. Further assumed the tests belonging to Clinical Laboratory (CL) and Neurology (N) which have data for all the days have been conducted every day.
2. Mechanical Ventilators and incubated are the same thing
3. Chest X-rays (CXRs) are the most frequent radiological tests performed in the intensive care unit (ICU)
4. Continuous renal replacement therapy is a special type of dialysis that we do for unstable patients in the ICU whose bodies cannot tolerate regular dialysis. Instead of doing it over four hours, CRRT is done 24 hours a day to slowly and continuously clean out the waste products and fluid from the patient.

Total patients moving from Ward to ICU = 35

Total patients moving from ICU to Ward = 26

## The number of departments that we can assume

The admission happens in the Ward or the ICU

1. Ward (W)
2. Intensive Care Unit (ICU)
3. Clinical Laboratory (CL)
4. Neurology (N)
5. Emergency Department (ED)
6. X-Ray/CT scan Room (XR)
7. Cardiology Department (CD)
8. Surgery Department (SD)
9. Others (O)

Permutation:

1. W, ICU, CL, N
2. ICU, W, CL, N
3. W, CL, ICU, N
4. ICU, CL, W, N
5. ICU, CL, N, W
6. ICU, N, CL, W
7. W, N, CL, ICU
8. W, CL, N, ICU
9. ICU, W, N, CL
10. W, ICU, N, CL
11. ICU, N, W, CL
12. W, N, ICU, CL

# Tab: Days Breakdown

Eg: A patient with ID 10 stays in the hospital for 14 days

1. systolic\_blood\_pressure
2. diastolic\_blood\_pressure
3. heart\_rate
4. respiratory\_rate
5. temperature
6. highest\_heart\_rate
7. Lowest\_heart\_rate
8. oxygen\_saturation
9. highest\_mean\_arterial\_pressure
10. lowest\_mean\_arterial\_pressure
11. highest\_creatinine
12. highest\_ph
13. lowest\_ph
14. highest\_gcs
15. Lowest\_gcs
16. Intubated
17. cardiac\_arrest
18. arrested\_time
19. Major\_cardiac\_events
20. Clinically\_diagnosed\_infections
21. mechanical\_ventilation
22. number\_of\_vasoactive\_agents
23. antiarrhythmic\_therapies
24. renal\_replacement\_therapy\_dialysis
25. cardiovascular\_mechanical\_support
26. fluid\_balance
27. wbc
28. rbc
29. hemoglobin
30. hematocrit
31. platelet\_count
32. aptt\_aptr
33. pt
34. alt
35. ast
36. mch
37. Mcv
38. Mchc
39. Rdw
40. Serum\_creatinine
41. Sodium
42. potassium
43. Total\_serum\_bilirubin
44. lactate
45. pao2
46. pao2\_fio2
47. ph
48. high\_sensitivity\_cardiac\_troponin
49. esr
50. inr
51. Ferritin
52. D\_dimer
53. Crp
54. hs\_crp
55. echocardiogram
56. ejection\_fraction
57. wall\_motion\_abnormality
58. chest\_x\_ray
59. cxr\_findings
60. chest\_ct
61. chest\_ct\_findings
62. head\_ct
63. head\_ct\_findings
64. antimicrobial
65. anticoagulation
66. steroid

### Statistics

R. Number of people who are intubated = 297

Number of people who are not intubated = is 376

As per what I checked the incubation happens in the Emergency Department or the ICU. Which means 297 people have been through the ED.

U. Cardiac Arrest

Out of all people, only 1 person had a cardiac arrest

X. clinically\_diagnosed\_infections

People with clinically\_diagnosed\_infections = 363

As per what I checked the clinically\_diagnosed\_infections are checked through urine tests and this pathology is done at the clinical laboratory (CL)

AB. renal\_replacement\_therapy\_dialysis

Renal replacement means one or both of your kidneys no longer function well and you need a replacement.

The common treatment for kidney replacement is dialysis. To undergo dialysis, a patient must first have a surgical procedure (source [Yale Medicine](https://www.yalemedicine.org/conditions/preparing-dialysis-av-fistula#:~:text=To%20undergo%20dialysis%2C%20a%20patient,the%20circulatory%20(vascular)%20system.))

No. of people who have had 45 Renal replacement

# Tab: Hospital\_length\_of \_stay

C. Did\_the\_patient\_expire\_in\_hospital

No = 418

Yes = 90

D. reason\_for\_death

1. COVID-19 Pneumonia
2. COVID-Pneumonia
3. Hypernatremia
4. COVID-19
5. Respiratory Failure due to COVID-19
6. Septic Shock
7. COVID 19
8. Complications related to bacteremia - urosepsis
9. COVID
10. COVID 19 pneumonia
11. MULTI-ORGAN FAILURE SHOCK
12. Profound hypoxic respiratory failure
13. Multi-system organ failure
14. Hypoxia
15. Dementia
16. Complications of Dementia
17. Viral Pneumonia
18. COVID PNEUMONIA
19. Cardiorespiratory arrest
20. Cardiorespiratory Failure
21. ARDS
22. Adult Respiratory Distress Syndrome
23. Klebsiella Pneumonia
24. Respiratory Failure
25. COVID-19
26. Bacteremia E-coli
27. Acute limb Ischemia
28. Cardio-Respiratory failure second degree to COVID-19
29. Pneumonia

Number of death counts

COVID related =

E. days\_in\_hospital\_prior\_to\_expiration

Max = 69

Min = 1

G. icu\_length\_of\_stay

People admitted to the ICU = 117

People admitted to the hospital before icu\_admission = 64 (So these people must be in the ward)

Do we consider ICU and mechanical ventilators the same?

F. hospital\_length\_of\_stay

Maximum LoS = 81

Minimum LoS = 1

### Medical terms

1. Incubation:

* The insertion of a tube into a patient's body, especially that of an artificial ventilation tube into the trachea.
* Incubation commonly takes place in the ICU

1. Tracheal intubation is the accepted gold standard for emergency department (ED)

Divided into Blood Work and General Checks

Blood tests are usually done on admission to the ICU.

I would assume the General check like temperature, motor, and verbal checks are done in the ward. Unless and until the patient is in a critical condition and started off in the ICU.

1. Respiratory Rate

Counting the number of breaths you take over one minute while you're at rest

The clinical laboratory typically does blood work.

1. Cardiac Catheterization: Cardiac catheterization (kath-uh-tur-ih-ZAY-shun) is a procedure in which a thin, flexible tube (catheter) is guided through a blood vessel to the heart to diagnose or treat certain heart conditions, such as clogged arteries or irregular heartbeats.
2. Motor Response - Obeys commands

You must get the patient to follow a simple command such as stick your tongue out or lift up your right arm

1. Creatinine: How well your kidneys are performing their jobs.

Ward/The Central Nervous System(Neurology)

# Tab: COVID Admitted

Previous ER Visit = 78

No previous ER Visit = 194

Prominent

Asthma = 13

* Ward = 13
* ICU = 0

Cancer = 3

* Ward = 2
* ICU = 1

Chronic cardiac disease (not hypertension) = 35

* Ward = 33
* ICU = 2

Chronic pulmonary (lung) = 4

* Ward = 4
* ICU = 0

Dementia = 1 (Ward)

Diabetes = 16

* Ward = 13
* ICU = 1

History of cancer [now in remission] = 3 (Ward)

Hypertension = 122

* Ward = 112
* ICU = 10

Kidney disease = 1 (Ward)

Liver disease = 1 (Ward)

Obesity = 3 (Ward)

Other = 35

* Ward = 33
* ICU = 2

Pregnancy = 3 (Ward)

Rheumatologic disorder = 2 (Ward)

Rules:

# Presentation

What are clinical pathways?

It is the identification of the “trajectories” that patients follow during the treatment process. In general, we can define it as the typical care paths for a certain group of patients.

What is hospital monitoring?

It is the healthcare process and activity within the hospital. This entails the movement of patients within a hospital or a group of its departments. For a hospital to offer patients a full range of care, a wide range of specialties is required. departments like those for pediatrics, emergency medicine, neurology, nephrology, cancer, imaging, and cardiology.

Queueing theory

This paper identifies queueing theory as one of the limited resources involved in a patient's care process. They have considered this during their simulation application. (waiting for results, priorities, etc.

Related Work

**TALK ABOUT REFERENCES IN-HOSPITAL MONITORING AND CLINICAL PATHWAYS**

Automatically Determining the Number of Clusters in Unlabeled Data Sets

Liang Wang; Christopher Leckie; Kotagiri Ramamohanarao; James Bezdek

**Empirical Results - Hospital Monitoring**

Nodes = Departments within a hospital. We developed this by considering the characteristics of tests that have been on patients and their comorbidities. For Eg: If a patient has been through cardiovascular\_mechanical\_support then they must have been in the cardiology department. There are patients with Cancer as comorbidities so we have assumed that they must have done some treatments related to the cancer department.

If hospital-length-of-stay > icu-length-of-stay -> inferred-ward (at the very least s/he has to move to the ward or possibly another department)

So inferred-ward = 1, if the above rule is true and 0 otherwise; we can edit this further by admission-disposition i.e. if admission-disposition=WARD, then patient went back to ward and inferred-ward can be updated to 0; else if admission-disposition = ICU, patient went to ward and inferred-ward=1

The rule I want to have is this -> if (chest-xray = YES) OR (chest-ct=YES) -> inferred imagining = 1.

inferred-icu -> if admission\_disposition = WARD, but (icu-length-of-stay > 0) , then inferred-icu=1

Assumptions:

* Assumed a patient to moves from Ward to ICU

We consider ICU/Incubation and mechanical ventilators the same.

We are using GNN rather than clustering used on the paper.

What we are looking to achieve is when new patient comes in with their individual characteristics, how will they go through the hospital monitoring systems?

It is Bidirectional as a patient can move back and forth from one node to the other(here node represents departments). For eg: A patient can enter in Ward and then move to ICU and then back to Ward.

**Empirical Results - Clinical Pathway**

We classified the nodes as departments in a hospital. The movement through the nodes is described with arrows. These arrows can be bidirectional. An example between two nodes would be

The way we have classified the patients in different departments for this dataset is done manually using the filter. But the rest of the project needs to be automated so that we can involve the use of GNN.

**Future Work**

The way paper comes up with the Clinical Pathways is by looking at the timestamps in the EHR data. Date Time Dep. Event

1-Jan 18:43 AD Hospital entrance

1-Jan 19:22 IC #2 Department entrance

1 medical test was done

1-Jan 19:22 IC #2 Check-up by an intensivist

16 medical tests were done

1-Jan 23:18 SD #1 Coronary catheterization

7 medical tests were done

2-Jan 11:34 IC #2 Check-up by an intensivist

1 medical test was done

2-Jan 11:44 IC #2 Check-up by an intensivist

If we had similar data of EHR with timestamps we would know for a fact the Clinical Pathways rather than assumptions.

We are looking into additional datasets that have granular details for the EHR data.

inferred\_cardiology:

Ward

Expired = 31

Not Expired = 51

Total = 82

ICU

Not Expired = 7

inferred\_image:

Ward

Expired = 65

Not Expired = 187

Total = 252

ICU

Expired = 3

Not Expired = 20

Total = 23

inferred\_neurology

Ward

Expired = 11

Not Expired = 20

Total = 31

ICU

Expired = 1

Not Expired = 2

Total = 3

inferred\_nephrology

Ward

Expired = 3

Not Expired = 5

Total = 8

inferred\_cancer

Ward

Expired = 1

Not Expired = 7

Total = 8

inferred\_isolation

Ward

Expired = 66

Not Expired = 194

Total = 260

ICU

Expired = 3

Not Expired = 20

Total = 23