

## Supplemental data

**Table S1: The key findings of the included article**

| Study                      | Design                                   | Age (Years)                                  | Male, n (%) | Findings                                                                                                                                                                                                                                                                                                             |
|----------------------------|------------------------------------------|----------------------------------------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wang et al. (2020) [19]    | Retrospective case series, single center | The majority (51%) were in the range (49–30) | NM          | Sputum and blood were the sources of the patient samples evaluated for co-pathogens.                                                                                                                                                                                                                                 |
| Yang et al. (2020) [20]    | Retrospective case series, single center | The majority (73%) were in the range (79–50) | NM          | Hospital-acquired illnesses were brought on by the identified germs.                                                                                                                                                                                                                                                 |
| Zhu et al. (2020) [21]     | Retrospective cohort, single center      | The median (IQR), 51 (99–2)                  | (53.7) 138  | Patients aged 15–44 and under 15 had the highest and lowest incidence of co-infections, respectively. The majority of co-infections happened 1-4 days after the COVID-19 disease started. In cases of severe COVID-19, the percentage of viral, fungal, and bacterial co-infections was highest.                     |
| Falcone et al. (2020) [22] | Retrospective cohort, single center      | The median age was 71 years (IQR 60–78.5)    | 51 (73.9)   | Infections caused by several microbes made up 18.3%. The following factors were found to be significant predictors of superinfections: intestinal colonization by CAR-resistant Enterobacterales (OR 16.03, 95% CI 6.5-39.5, $P < 0.001$ ), invasive mechanical ventilation (OR 5.6, 95% CI 2.4-13.1, $P < 0.001$ ). |
| Chen et al. (2020) [23]    | Retrospective case series, single center | Tme mean (SD), 55.5 (13.1)                   | 67 (67.7)   | Six individuals (6%) had elevated procalcitonin levels.                                                                                                                                                                                                                                                              |
| Hughes et al. (2020) [24]  | Retrospective case series, multi-center  | The median (IQR), 69 (55–81)                 | 519 (62.0)  | In the initial stages of hospital admission, the rate of bacterial co-infection in SARS-CoV-2 patients was low.                                                                                                                                                                                                      |
| Li et al. (2020) [25]      | Retrospective case series, multi- center | The median (IQR), 57 (47–69)                 | 11 (78.6)   | Patients with co-infections of SARS-CoV-2 were admitted to the ICU more frequently ( $p < 0.05$ ), displayed more severe respiratory problems, and were more likely to develop sequelae such ARDS and shock.                                                                                                         |

|                              |                                          |                                                                     |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| Intra et al. (2020) [26]     | Prospective cohort, multi-center         | The most common age range was between 51 and 70 years (%36.2)       | 144 (55.4) | Co-infections were found in 20 (71.4%) severe COVID-19 patients and eight (28.6%) moderate cases of co-infection. Co-infections contributed to 25% of SARS-CoV-2 patients' deaths, and co-infected patients' SARS-CoV-2 complications and severity were both more severe. In Upper Egypt, bacterial co-infection and antibiotic resistance are frequent among COVID-19 patients.                                                                                                                                                                                                                                                                                                                                                                                                              |
| Cataldo et al. (2020) [27]   | Retrospective cohort, single center      | NM                                                                  | NM         | There was no association between hospital mortality with early or any respiratory sample pathogen isolation ( $p = 0.512$ and $p = 1.0$ , respectively).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Nasir et al. (2020) [28]     | Retrospective case series, single center | The median (IQR), 63 (60–68)                                        | 47 (82.0)  | The APACHE II score was substantially correlated with co-infection, which occurred a median of 9 days (IQR 5–11) after admission ( $p = 0.02$ ). Co-infection was substantially linked to both a longer ICU stay and death (OR 2.7, 95% CI 1.2–5.9, $p = 0.015$ ).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Ramadan et al. (2020) [6]    | Retrospective cohort, single center      | NM                                                                  | NM         | Severe COVID-19 patients had a higher prevalence of fungal and <i>P. aeruginosa</i> colonization than non-COVID-19 cases, it was found.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Sepulveda et al. (2020) [29] | Retrospective cohort, single center      | The mean age ( $\pm$ standard deviation, SD) was $62 \pm 13$ years  | 41 (72.0)  | The following are probable major contributors to the high occurrence of bacterial and fungal infections in COVID-19 patients: 1) The significant COVID-19 immunological dysregulation; 2) the widespread use of antibiotics; and 3) the lack of commitment to infection control and prevention (IPC) methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Wang et al. (2021) [30]      | Retrospective case series, single center | The median (IQR), 71 (51–85)                                        | 7 (77.8)   | Patients with moderate to severe COVID-19 experience the complication of invasive aspergillosis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| May et al. (2021) [31]       | Retrospective cohort, multi-center       | NM                                                                  | NM         | When compared to COVID-19-negative patients, the rate of bacteremia was considerably lower in COVID-19 patients (3.8% vs. 8.0%; $p = 0.001$ ). Within four days of incubation, more than 98% of all positive cultures had been discovered. True bacteremia was most frequently caused by <i>E. coli</i> (16.7%), <i>S. aureus</i> (13.3%), <i>K. pneumoniae</i> (10.0%), and <i>Enterobacter cloacae</i> complex (8.3%) in COVID-19 patients. When compared to SARS-CoV-2 patients without co-infections, ICU admission and mortality did not differ between the groups [215 (15.8%) vs. 11 (29.7%), $p = 0.075$ ] and [410 (30.2%) vs. 10 (27.0%), $p = 0.68$ ], respectively. Within 48 hours of admission, bacterial co-infection was uncommon in COVID-19 patients who were hospitalized. |
| Yang et al. (2021) [32]      | Retrospective cohort, multi-center       | The median (IQR), 76 (82–64)                                        | 28 (75.7)  | More <i>P. aeruginosa</i> was found in the initial stages of ICU admission. <i>Staphylococcus aureus</i> and <i>Acinetobacter baumannii</i> were more frequently found with late ICU admission. Compared to the severe group, the critical group's fungal serum antigens                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Gerver et al. (2021) [33]    | Retrospective cohort, single center      | The median age of 39 years (interquartile range, IQR, 36–67 years). | 9 (45.0)   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

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|                                    |                                     | the critical group with a median age of 69 years (IQR, 64-80 years) |            | were more commonly positive, and the frequency of positive fungal serum antigens rose with length of ICU stay.                                                                                                                                                                                                                                                                                    |
| Nori et al. (2021) [34]            | Retrospective cohort, single center | The median 70 years [IQR:58-81]                                     | 524(59.6)  | Escherichia coli, Staphylococcus aureus, and Klebsiella pneumoniae were the most typical pathogens. A higher number of cases with secondary infection were of Black or Asian ethnicity than cases without (67% vs. 41% and 99% vs. 82%, respectively, p0001). Cases with co/secondary infections were also older than cases without (median 70 years [IQR:58-81] vs. 55 years [IQR:38-77]).       |
| Bardi et al. (2021) [35]           | Retrospective cohort, single center | The median age of 62 years (IQR 52.5-72)                            | 90(59.0)   | Only 5% of patients had bacterial and fungal co-infections, but because they often affect the most vulnerable individuals, they are a serious issue.                                                                                                                                                                                                                                              |
| Shafiekhani et al. (2022) [36]     | Retrospective cohort, single center | The mean±SD age of the patients was 55.22±9.91 years                | 39(59.1)   | During their COVID-19 course, 21% of the patients experienced co-infection at least once. Co-infections with fungi and bacteria led to much greater mortality. The most typical locations for pathogen isolation were urine and sputum (45.45% and 36.36%, respectively). VAN-resistant Enterococci (30%) were the primary cause of infections. With 23.3%, Escherichia coli was in second place. |
| Ruiz-Rodriguez et al. (2022) [37]  | Retrospective cohort, single center | The mean±SD age of the patients was 58±11 years                     | 24 (80.0)  | A direct correlation between the abundance of a certain microbial species and microbial expansion (high biomass). Pathogen proliferation correlated with the patient's antibiotic treatment's selective pressure.                                                                                                                                                                                 |
| Alnimr et al. (2022) [38]          | Retrospective cohort, single center | The median age for all patients were 48 years±4.3.                  | 54 (79.4)  | Gram-negative pathogens (Enterobacterales, Pseudomonas aeruginosa, and Acinetobacter baumannii) made up more than 50% of the etiological agents, and co-infection was observed in 67/68 non-survivors.                                                                                                                                                                                            |
| Naseef et al. (2022) [39]          | Retrospective cohort, single center | 170 (48.9%) were 41-64 years of age                                 | (50.5) 162 | 51.1% of isolates were co-infected with bacteria, mostly gram-negative isolates (Enterobacter species and K.pneumoniae). A. fumigatus caused a 48.9% fungal co-infection rate and an 8.1% death rate.                                                                                                                                                                                             |
| Nebreda-Mayoral et al. (2022) [40] | Retrospective cohort, single center | Their median age was 73 years (IQR 57-89)                           | 420(59.0)  | An important contributing reason to the rises in infection rates and morbidity among ICU patients was the A. baumannii outbreak.                                                                                                                                                                                                                                                                  |
| Shafiekhani et al. (2022) [36]     | Retrospective cohort, single center | The mean±SD age of the patients was 55.22±9.91 years                | 11(78.5)   | Co-infections with fungi and bacteria led to much greater mortality. The most typical locations for pathogen isolation were urine and sputum (45.45% and 36.36%, respectively).                                                                                                                                                                                                                   |