SOBREINFECCIÓN BACTERIANA Y FÚNGICA EN PACIENTES ADMITIDOS CON NEUMONÍA POR SARS-COV-2 EN UNA UNIDAD DE CUIDADOS INTENSIVOS DE BARRANQUILLA COLOMBIA DURANTE EL AÑO 2020

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Trabajo de Investigación presentado como requisito para optar el título de:
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RESUMEN

Introducción: La sobreinfección bacteriana y fúngica en adultos con COVID-19 en cuidado critico es poco conocida. La evidencia reporta que son un factor de riesgo importante para resultados adversos de la COVID-19, que impacta en mortalidad y la eficiencia de atención en salud.
Objetivos: Determinar la existencia de sobreinfección bacteriana y fúngica en pacientes admitidos con neumonía por SARS-CoV-2 hospitalizados en una unidad de cuidados intensivos de Barranquilla, Colombia.
Materiales y métodos: Se utilizó un estudio descriptivo, retrospectivo, cuantitativo de corte transversal. La población estuvo constituida con pacientes admitidos por neumonía con SARS-CoV-2 en una unidad de cuidados intensivos de Barranquilla, Colombia, desde el 14 de abril del 2020 al 31 de diciembre del 2020. Se revisaron los registros clínicos y microbiológicos. Las muestras de cultivos fueron tomadas previo al inicio de terapia antibiótica o durante las primeras 48 horas después de su inicio o antes de cumplir 48 horas de estancia en cuidados intensivos.

Resultados: Se recolectaron 167 pacientes, de los cuales el 36.5% (n=61) presentaban aislamientos positivos en alguno de los cultivos analizados. En el análisis univariado el requerimiento de ventilación mecánica, estancia hospitalaria prolongada y el uso de claritromicina presentaron diferencias estadísticamente significativas.
Conclusiones: La frecuencia de sobreinfección bacteriana y fúngica fue baja, sin embargo, en el uso de terapia antimicrobiana empírica fue alta. La vigilancia del consumo y uso de antimicrobianos puede ser de ayuda para identificar el uso inapropiado y el perfil de susceptibilidad local.

Palabras clave: Cuidados intensivos; COVID-19; Sobreinfección; neumonía grave; Antibióticos.

ABSTRACT

Introduction: Bacterial and fungal superinfection in adults with COVID-19 in critical care is poorly understood. The evidence reports that they are an important risk factor for adverse outcomes of COVID-19, which impacts mortality and the efficiency of health care.
Objectives: To determine the existence of bacterial and fungal superinfection in patients admitted with SARS-CoV-2 pneumonia hospitalized in an intensive care unit in Barranquilla, Colombia.
Materials and Methods: A descriptive, retrospective, quantitative cross-sectional study was used. The population consisted of patients admitted for confirmed SARS-CoV-2 pneumonia in an intensive care unit in Barranquilla, Colombia, from April 14, 2020 to December 31, 2020. Clinical and microbiological records were reviewed. Culture samples were taken prior to the start of antibiotic therapy, during the first 48 hours after its initiation or before completing 48 hours of stay in intensive care
Results: 167 patients were collected, of which 36.5% (n=61) had positive isolates in any of the cultures analyzed. In the univariate analysis, the requirement for mechanical ventilation, prolonged hospital stay and the use of clarithromycin presented statistically significant differences.
Conclusions: The frequency of bacterial and fungal superinfection was low, however, in the use of empiric antimicrobial therapy it was high. Surveillance of antimicrobial consumption and use can be helpful in identifying inappropriate use and the local susceptibility profile

Key Words:
Intensive care; COVID-19; Superinfection; Severe pneumonia; Antibiotics.

REFERENCIAS BIBLIOGRÁFICAS

1. Douthit BJ. The influence of the learning health system to address the COVID-19 pandemic: An examination of early literature. Int J Health Plann Manage [Internet]. 2021;36(2):244–51. Disponible en: http://dx.doi.org/10.1002/hpm.3088

2. Nebreda-Mayoral T, Miguel-Gómez MA, March-Rosselló GA, Puente-Fuertes L, Cantón-Benito E, Martínez-García AM, et al. Bacterial/fungal infection in hospitalized patients with COVID-19 in a tertiary hospital in the Community of Castilla y León, Spain. Enferm infecc microbiol clin (Engl) [Internet]. 2020;40(4):158–65. Disponible en: http://dx.doi.org/10.1016/j.eimc.2020.11.003

3. Dong E, Du H, Gardner L. An interactive web-based dashboard to track COVID-19 in real time. Lancet Infect Dis [Internet]. 2020;20(5):533–4. Disponible en: http://dx.doi.org/10.1016/S1473-3099(20)30120-1

4. Yap FHY, Gomersall CD, Fung KSC, Ho P-L, Ho O-M, Lam PKN, et al. Increase in methicillin-resistant Staphylococcus aureus acquisition rate and change in pathogen pattern associated with an outbreak of severe acute respiratory syndrome. Clin Infect Dis [Internet]. 2004;39(4):511–6. Disponible en: http://dx.doi.org/10.1086/422641

5. Bengoechea JA, Bamford CG. SARS-CoV-2, bacterial co-infections, and AMR: the deadly trio in COVID-19? EMBO Mol Med [Internet]. 2020;12(7):e12560. Disponible en: http://dx.doi.org/10.15252/emmm.202012560

6. Lamers MM, Beumer J, van der Vaart J, Knoops K, Puschhof J, Breugem TI, et al. SARS-CoV-2 productively infects human gut enterocytes. Science [Internet]. 2020;369(6499):50–4. Disponible en: http://dx.doi.org/10.1126/science.abc1669

7. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet [Internet]. 2020;395(10229):1054–62. Disponible en: http://dx.doi.org/10.1016/S0140-6736(20)30566-3

8. Docherty AB, Harrison EM, Green CA, Hardwick HE, Pius R, Norman L, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ [Internet]. 2020;369:m1985. Disponible en: http://dx.doi.org/10.1136/bmj.m1985

9. Garcia-Vidal C, Sanjuan G, Moreno-García E, Puerta-Alcalde P, Garcia-Pouton N, Chumbita M, et al. Incidence of co-infections and superinfections in hospitalized patients with COVID-19: a retrospective cohort study. Clin Microbiol Infect [Internet]. 2021;27(1):83–8. Disponible en: http://dx.doi.org/10.1016/j.cmi.2020.07.041

10. Huttner BD, Catho G, Pano-Pardo JR, Pulcini C, Schouten J. COVID-19: don't neglect antimicrobial stewardship principles! Clin Microbiol Infect [Internet]. 2020;26(7):808–10. Disponible en: http://dx.doi.org/10.1016/j.cmi.2020.04.024

11. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. Lancet [Internet]. 2020;395(10223):507–13. Disponible en: http://dx.doi.org/10.1016/S0140-6736(20)30211-7

12. Zhou P, Yang X-L, Wang X-G, Hu B, Zhang L, Zhang W, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature [Internet]. 2020;579(7798):270–3. Disponible en: http://dx.doi.org/10.1038/s41586-020-2012-7

13. Aguilera Calzadilla Y, Díaz Morales Y, Ramos Suzarte M. Infecciones bacterianas y fúngicas asociadas a la COVID-19. Medicentro (Villa Cl) [Internet]. 2021 [citado el 7 de octubre de 2022];25(2):315–23. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1029-30432021000200315

14. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med [Internet]. 2020;8(5):475–81. Disponible en: http://dx.doi.org/10.1016/S2213-2600(20)30079-5

15. Lv Z, Cheng S, Le J, Huang J, Feng L, Zhang B, et al. Clinical characteristics and co-infections of 354 hospitalized patients with COVID-19 in Wuhan, China: a retrospective cohort study. Microbes Infect [Internet]. 2020;22(4–5):195–9. Disponible en: http://dx.doi.org/10.1016/j.micinf.2020.05.007

16. Rawson TM, Moore LSP, Zhu N, Ranganathan N, Skolimowska K, Gilchrist M, et al. Bacterial and fungal coinfection in individuals with Coronavirus: A rapid review to support COVID-19 antimicrobial prescribing. Clin Infect Dis [Internet]. 2020;71(9):2459–68. Disponible en: http://dx.doi.org/10.1093/cid/ciaa530

17. Lansbury L, Lim B, Baskaran V, Lim WS. Co-infections in people with COVID-19: a systematic review and meta-analysis. J Infect [Internet]. 2020;81(2):266–75. Disponible en: http://dx.doi.org/10.1016/j.jinf.2020.05.046

18. Berenguer J, Ryan P, Rodríguez-Baño J, Jarrín I, Carratalà J, Pachón J, et al. Characteristics and predictors of death among 4035 consecutively hospitalized patients with COVID-19 in Spain. Clin Microbiol Infect [Internet]. 2020;26(11):1525–36. Disponible en: http://dx.doi.org/10.1016/j.cmi.2020.07.024

19. Langford BJ, So M, Raybardhan S, Leung V, Westwood D, MacFadden DR, et al. Bacterial co-infection and secondary infection in patients with COVID-19: a living rapid review and meta-analysis. Clin Microbiol Infect [Internet]. 2020;26(12):1622–9. Disponible en: http://dx.doi.org/10.1016/j.cmi.2020.07.016

20. Calzadilla YA, Morales YD, Díaz LAO, Martínez OLG, Enríquez OAL, de Lourdes Sánchez Álvarez M. Infecciones bacterianas asociadas a la COVID-19 en pacientes de una unidad de cuidados intensivos. Rev cuba med mil [Internet]. 2020 [citado el 7 de octubre de 2022];49(3):0200793. Disponible en: http://www.revmedmilitar.sld.cu/index.php/mil/article/view/793/539

21. Mejia P, Gerardo Y. Infecciones asociadas a la COVID-19 en pacientes hospitalizados. 2021. Universidad Nacional de Colombia; 2022.

22. Para O, Caruso L, Ronchetti M, Finocchi M, Guidi S, Spinicci M. Superinfection with difficult-to-treat bacteria in COVID-19 patients: a call for compliance with diagnostic and antimicrobial stewardship. Intern Emerg Med [Internet]. 2021;16(3):789–91. Disponible en: http://dx.doi.org/10.1007/s11739-020-02537-3

23. Mirzaei R, Goodarzi P, Asadi M, Soltani A, Aljanabi HAA, Jeda AS, et al. Bacterial co-infections with SARS-CoV-2. IUBMB Life [Internet]. 2020;72(10):2097–111. Disponible en: http://dx.doi.org/10.1002/iub.2356

24. Kim D, Quinn J, Pinsky B, Shah NH, Brown I. Rates of co-infection between SARS-CoV-2 and other respiratory pathogens. JAMA [Internet]. 2020;323(20):2085–6. Disponible en: http://dx.doi.org/10.1001/jama.2020.6266

25. Cataldo MA, Tetaj N, Selleri M, Marchioni L, Capone A, Caraffa E, et al. Incidence of bacterial and fungal bloodstream infections in COVID-19 patients in intensive care: An alarming “collateral effect”. J Glob Antimicrob Resist

[Internet]. 2020;23:290–1. Disponible en: http://dx.doi.org/10.1016/j.jgar.2020.10.004

26. Benmalek R, Mechal H, Choukrallah H, Maaroufi A, Benouna EG, Habbal R, et al. Bacterial co-infections and superinfections in COVID-19: a case report of right heart infective endocarditis and literature review. Pan Afr Med J [Internet]. 2020;35(Suppl 2):40. Disponible en: http://dx.doi.org/10.11604/pamj.supp.2020.35.2.23577

27. Rivero JAV, Ledezma JCR, Pacheco IH, del Refugio Acuña Gurrola M, Pontigo LL. La Salud de las Personas Adultas Mayores durante la Pandemia de COVID-19. J negat no posit results [Internet]. 2020 [citado el 7 de octubre de 2022];5(7):726–39. Disponible en: https://revistas.proeditio.com/jonnpr/article/view/3772

28. Ye Z-W, Yuan S, Yuen K-S, Fung S-Y, Chan C-P, Jin D-Y. Zoonotic origins of human coronaviruses. Int J Biol Sci [Internet]. 2020;16(10):1686–97. Disponible en: http://dx.doi.org/10.7150/ijbs.45472

29. Sun K, Chen J, Viboud C. Early epidemiological analysis of the coronavirus disease 2019 outbreak based on crowdsourced data: a population-level observational study. Lancet Digit Health [Internet]. 2020;2(4):e201–8. Disponible en: http://dx.doi.org/10.1016/S2589-7500(20)30026-1

30. Yi C, Sun X, Ye J, Ding L, Liu M, Yang Z, et al. Key residues of the receptor binding motif in the spike protein of SARS-CoV-2 that interact with ACE2 and neutralizing antibodies. Cell Mol Immunol [Internet]. 2020;17(6):621–30. Disponible en: http://dx.doi.org/10.1038/s41423-020-0458-z

31. Peghin M, Vena A, Graziano E, Giacobbe DR, Tascini C, Bassetti M. Improving management and antimicrobial stewardship for bacterial and fungal infections in hospitalized patients with COVID-19. Ther Adv Infect Dis [Internet]. 2022;9:20499361221095732. Disponible en: http://dx.doi.org/10.1177/20499361221095732

32. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel Coronavirus-infected pneumonia in Wuhan, China. JAMA [Internet]. 2020;323(11):1061–9. Disponible en: http://dx.doi.org/10.1001/jama.2020.1585

33. Elabbadi A, Turpin M, Gerotziafas GT, Teulier M, Voiriot G, Fartoukh M. Bacterial coinfection in critically ill COVID-19 patients with severe pneumonia. Infection [Internet]. 2021;49(3):559–62. Disponible en: http://dx.doi.org/10.1007/s15010-020-01553-x

34. Bazaid AS, Barnawi H, Qanash H, Alsaif G, Aldarhami A, Gattan H, et al. Bacterial coinfection and antibiotic resistance profiles among hospitalised COVID-19 patients. Microorganisms [Internet]. 2022;10(3):495. Disponible en: http://dx.doi.org/10.3390/microorganisms10030495

35. Silva DL, Lima CM, Magalhães VCR, Baltazar LM, Peres NTA, Caligiorne RB, et al. Fungal and bacterial coinfections increase mortality of severely ill COVID-19 patients. J Hosp Infect [Internet]. 2021;113:145–54. Disponible en: http://dx.doi.org/10.1016/j.jhin.2021.04.001

36. Algarín-Lara H, Guevara-Romero E, Osorio-Rodríguez E, Patiño-Patiño J, Flórez García V, Tuesca R de J, et al. Factores relacionados con la neumonía bacteriana en pacientes con COVID-19 en una unidad de cuidados intensivos de Barranquilla, Colombia. Acta Colomb Cuid Intensivo [Internet]. 2022;22:S28–35. Disponible en: http://dx.doi.org/10.1016/j.acci.2021.07.002

37. Soltani S, Zandi M, Faramarzi S, Shahbahrami R, Vali M, Rezayat SA, et al. Worldwide prevalence of fungal coinfections among COVID-19 patients: a comprehensive systematic review and meta-analysis. Osong Public Health Res Perspect [Internet]. 2022;13(1):15–23. Disponible en: http://dx.doi.org/10.24171/j.phrp.2021.0293

38. Casalini G, Giacomelli A, Ridolfo A, Gervasoni C, Antinori S. Invasive fungal infections complicating COVID-19: A narrative review. J Fungi (Basel) [Internet]. 2021;7(11):921. Disponible en: http://dx.doi.org/10.3390/jof7110921

39. Gonzáles Mendoza J, Maguiña Vargas C, Gonzáles Ponce F de M. La resistencia a los antibióticos: un problema muy serio. Acta médica peru [Internet]. 2019 [citado el 7 de octubre de 2022];36(2):145–51. Disponible en: http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1728-59172019000200011&lng=es&tlng=es

40. Saavedra Trujillo CH. SECCIÓN I. Antecedentes de infección por SARS-CoV-2/COVID-19, SECCIÓN II. Definiciones operativas de casos de infección por SARS-CoV-2/COVID-19, SECCIÓN III. Clasificación clínica de casos y estratificación del riesgo de infección por SARS-CoV-2/COVID 19. Consenso colombiano de atención, diagnóstico y manejo de la infección por SARS-CoV-2/COVID-19 en establecimientos de atención de la salud: Recomendaciones basadas en consenso de expertos e informadas en la evidencia ACIN-IETS. SEGUNDA EDICIÓN. 1 de agosto de 2020. Infectio [Internet]. 2020 [citado el 7 de octubre de 2022];24(3):10–39. Disponible en: http://revistainfectio.org/index.php/infectio/article/view/972/1114

41. Zhang H, Zhang Y, Wu J, Li Y, Zhou X, Li X, et al. Risks and features of secondary infections in severe and critical ill COVID-19 patients. Emerg Microbes Infect [Internet]. 2020;9(1):1958–64. Disponible en: http://dx.doi.org/10.1080/22221751.2020.1812437

42. Moya-Salazar J, Sauñe SS, Valer R, Salazar-Hernandez R, Loza W, Suxe E, et al. Fungal, parasitological, and bacterial coinfection in a severely ill COVID-19 patient in Peru. Clin Case Rep [Internet]. 2022;10(2):e05395. Disponible en: http://dx.doi.org/10.1002/ccr3.5395

43. Ramzan K, Shafiq S, Raees I, Mustafa ZU, Salman M, Khan AH, et al. Co-infections, secondary infections, and antimicrobial use in patients hospitalized with COVID-19 during the first five waves of the pandemic in Pakistan; Findings and implications. Antibiotics (Basel) [Internet]. 2022;11(6):789. Disponible en: http://dx.doi.org/10.3390/antibiotics11060789

44. Ahmed N, Mahmood MS, Ullah MA, Araf Y, Rahaman TI, Moin AT, et al. COVID-19-associated candidiasis: Possible patho-mechanism, predisposing factors, and prevention strategies. Curr Microbiol [Internet]. 2022;79(5):127. Disponible en: http://dx.doi.org/10.1007/s00284-022-02824-6

45. Chen G, Wu D, Guo W, Cao Y, Huang D, Wang H, et al. Clinical and immunological features of severe and moderate coronavirus disease 2019. J Clin Invest [Internet]. 2020;130(5):2620–9. Disponible en: http://dx.doi.org/10.1172/JCI137244

46. Merad M, Martin JC. Pathological inflammation in patients with COVID-19: a key role for monocytes and macrophages. Nat Rev Immunol [Internet]. 2020;20(6):355–62. Disponible en: http://dx.doi.org/10.1038/s41577-020-0331-4

47. Pemán J, Ruiz-Gaitán A, García-Vidal C, Salavert M, Ramírez P, Puchades F, et al. Fungal co-infection in COVID-19 patients: Should we be concerned? Rev Iberoam Micol [Internet]. 2020;37(2):41–6. Disponible en: http://dx.doi.org/10.1016/j.riam.2020.07.001

48. Goncalves Mendes Neto A, Lo KB, Wattoo A, Salacup G, Pelayo J, DeJoy R 3rd, et al. Bacterial infections and patterns of antibiotic use in patients with COVID-19. J Med Virol [Internet]. 2021;93(3):1489–95. Disponible en: http://dx.doi.org/10.1002/jmv.26441

49. Algarín-Lara H, Rudas Moscarella JM, Aldana-Roa J, Patiño-Patiño J, Sajona-Nieves E, Aldana-Roa M, et al. Superinfección por

Stenotrophomonas maltophilia en pacientes con COVID-19 críticamente enfermos. Análisis de una serie de casos. Acta Colomb Cuid Intensivo [Internet]. 2022;22:S138–42. Disponible en: http://dx.doi.org/10.1016/j.acci.2021.08.001

50. Fattorini L, Creti R, Palma C, Pantosti A, Unit of Antibiotic Resistance and Special Pathogens, Unit of Antibiotic Resistance and Special Pathogens of the Department of Infectious Diseases, Istituto Superiore di Sanità, Rome. Bacterial coinfections in COVID-19: an underestimated adversary. Ann Ist Super Sanita [Internet]. 2020;56(3):359–64. Disponible en: http://dx.doi.org/10.4415/ANN_20_03_14

51. Arteaga-Livias K, Pinzas-Acosta K, Perez-Abad L, Panduro-Correa V, Rabaan AA, Pecho-Silva S, et al. A multidrug-resistant Klebsiella pneumoniae outbreak in a Peruvian hospital: Another threat from the COVID-19 pandemic. Infect Control Hosp Epidemiol [Internet]. 2022;43(2):267–8. Disponible en: http://dx.doi.org/10.1017/ice.2020.1401

52. Alqahtani A, Alamer E, Mir M, Alasmari A, Alshahrani MM, Asiri M, et al. Bacterial coinfections increase mortality of severely ill COVID-19 patients in Saudi Arabia. Int J Environ Res Public Health [Internet]. 2022;19(4):2424. Disponible en: http://dx.doi.org/10.3390/ijerph19042424

53. Huang B, Ling R, Cheng Y, Wen J, Dai Y, Huang W, et al. Characteristics of the Coronavirus Disease 2019 and related Therapeutic Options. Mol Ther Methods Clin Dev [Internet]. 2020;18:367–75. Disponible en: http://dx.doi.org/10.1016/j.omtm.2020.06.013

54. Dinnes J, Deeks JJ, Adriano A, Berhane S, Davenport C, Dittrich S, et al. Rapid, point-of-care antigen and molecular-based tests for diagnosis of SARS-CoV-2 infection. Cochrane Database Syst Rev [Internet]. 2020;8:CD013705. Disponible en: http://dx.doi.org/10.1002/14651858.CD013705

55. Langa LS, Sallent LV, Díez SR. 167-173 10.1016/j.Fmc.2021.01.005 Langa Laura Soldevila LS programa de Salud internacional (PROSICS) metropolitana Norte, servicio de enfermedades infecciosas, hospital Universitari Germans Trias i Pujol. Sallent lluís Valerio LV programa de Salud internacional (PROSICS) metropolitana Norte, servicio de atención primaria, Badalona, Barcelona, España. Díez sílvia Roure SR programa de Salud internacional (PROSICS) metropolitana Norte, servicio de enfermedades infecciosas, hospital Universitari Germans Trias i Pujol. Spa journal article interpretación de las pruebas diagnósticas de la COVID-19. 2021 03 23. FMC

- Form Médica Contin Aten Primaria [Internet]. 2021;28(3):167–73. Disponible en: http://dx.doi.org/10.1016/j.fmc.2021.01.005

56. Sethuraman N, Jeremiah SS, Ryo A. Interpreting diagnostic tests for SARS-CoV-2. JAMA [Internet]. 2020;323(22):2249–51. Disponible en: http://dx.doi.org/10.1001/jama.2020.8259

57. Who.int. [citado el 7 de octubre de 2022]. Disponible en: https://apps.who.int/iris/handle/10665/331736

58. Metlay JP, Waterer GW, Long AC, Anzueto A, Brozek J, Crothers K, et al. Diagnosis and treatment of adults with community-acquired pneumonia. An official clinical practice guideline of the American thoracic society and infectious diseases society of America. Am J Respir Crit Care Med [Internet]. 2019;200(7):e45–67. Disponible en: http://dx.doi.org/10.1164/rccm.201908-1581ST

59. Moreno-García E, Puerta-Alcalde P, Letona L, Meira F, Dueñas G, Chumbita M, et al. Bacterial co-infection at hospital admission in patients with COVID-19. Int J Infect Dis [Internet]. 2022;118:197–202. Disponible en: http://dx.doi.org/10.1016/j.ijid.2022.03.003

60. Hughes S, Troise O, Donaldson H, Mughal N, Moore LSP. Bacterial and fungal coinfection among hospitalized patients with COVID-19: a retrospective cohort study in a UK secondary-care setting. Clin Microbiol Infect [Internet]. 2020;26(10):1395–9. Disponible en: http://dx.doi.org/10.1016/j.cmi.2020.06.025

61. Søvik S, Barrat-Due A, Kåsine T, Olasveengen T, Strand MW, Tveita AA, et al. Corticosteroids and superinfections in COVID-19 patients on invasive mechanical ventilation. J Infect [Internet]. 2022;85(1):57–63. Disponible en: http://dx.doi.org/10.1016/j.jinf.2022.05.015

62. Rakiro J, Shah J, Waweru-Siika W, Wanyoike I, Riunga F. Microbial coinfections and superinfections in critical COVID-19: a Kenyan retrospective cohort analysis. IJID Reg [Internet]. 2021;1:41–6. Disponible en: http://dx.doi.org/10.1016/j.ijregi.2021.09.008

63. Abad CL, Sandejas JCM, Poblete JB, Malundo AFG, Salamat MSS, Alejandria MM. Bacterial coinfection and antimicrobial use among patients with COVID-19 infection in a referral center in the Philippines: A retrospective cohort study. IJID Reg [Internet]. 2022;4:123–30. Disponible en: http://dx.doi.org/10.1016/j.ijregi.2022.07.003

64. Said KB, Alsolami A, Alshammari F, Alreshidi FS, Fathuldeen A, Alrashid F, et al. Selective COVID-19 coinfections in diabetic patients with concomitant cardiovascular comorbidities are associated with increased mortality. Pathogens [Internet]. 2022;11(5):508. Disponible en: http://dx.doi.org/10.3390/pathogens11050508

65. Chang C-Y, Chan K-G. Underestimation of co-infections in COVID-19 due to non-discriminatory use of antibiotics. J Infect [Internet]. 2020;81(3):e29–30. Disponible en: http://dx.doi.org/10.1016/j.jinf.2020.06.077

66. Teich VD, Klajner S, Almeida FAS de, Dantas ACB, Laselva CR, Torritesi MG, et al. Epidemiologic and clinical features of patients with COVID-19 in Brazil. Einstein (Sao Paulo) [Internet]. 2020;18:eAO6022. Disponible en: http://dx.doi.org/10.31744/einstein_journal/2020ao6022

67. Bendala Estrada AD, Calderón Parra J, Fernández Carracedo E, Muiño Míguez A, Ramos Martínez A, Muñez Rubio E, et al. Inadequate use of antibiotics in the covid-19 era: effectiveness of antibiotic therapy. BMC Infect Dis [Internet]. 2021;21(1):1144. Disponible en: http://dx.doi.org/10.1186/s12879-021-06821-1

68. Doubravská L, Htoutou Sedláková M, Fišerová K, Pudová V, Urbánek K, Petrželová J, et al. Bacterial resistance to antibiotics and clonal spread in COVID-19-positive patients on a tertiary hospital intensive care unit, Czech Republic. Antibiotics (Basel) [Internet]. 2022;11(6):783. Disponible en: http://dx.doi.org/10.3390/antibiotics11060783

69. Min J-Y, Jang YJ. Macrolide therapy in respiratory viral infections. Mediators Inflamm [Internet]. 2012;2012:649570. Disponible en: http://dx.doi.org/10.1155/2012/649570

70. Lai C-C, Chen S-Y, Ko W-C, Hsueh P-R. Increased antimicrobial resistance during the COVID-19 pandemic. Int J Antimicrob Agents [Internet]. 2021;57(4):106324. Disponible en: http://dx.doi.org/10.1016/j.ijantimicag.2021.106324

71. Donà D, Di Chiara C, Sharland M. Multi-drug-resistant infections in the COVID-19 era: a framework for considering the potential impact. J Hosp Infect [Internet]. 2020;106(1):198–9. Disponible en: http://dx.doi.org/10.1016/j.jhin.2020.05.020

72. Jolivet S, Lolom I, Bailly S, Bouadma L, Lortat-Jacob B, Montravers P, et al. Impact of colonization pressure on acquisition of extended-spectrum β-lactamase-producing Enterobacterales and meticillin-resistant

Staphylococcus aureus in two intensive care units: a 19-year retrospective surveillance. J Hosp Infect [Internet]. 2020;105(1):10–6. Disponible en: http://dx.doi.org/10.1016/j.jhin.2020.02.012