Retrospective analysis of surgical patients during SARS - CoV-2 (COVID - 19) omicron surge in a teaching University Hospital.

Dr Surendranath Venkatesan [1], Dr Mahesh Bangalore Chandra [2], Dr Mahammad Shakeel Bairekate [2], Dr Faisal Almannai [3], Dr Kartheek Adapa [4], Dr Keith Johnston [5]*

[1]Senior Registrar, [2]Registrar, [3] Senior House Officer, [5]Consultant, Department of Anaesthesia,*

King Hamad University Hospital, Kingdom of Bahrain. [4] Director, Division of Clinical Informatics, UNC-School of Medicine, United States.

Abstract:

Omicron surge during SARS - CoV - 2 (COVID) pandemic, presented with different characteristics in comparison to earlier surges due to other Variants of Concern (VoC). Parameters like surgical outcome, including prolonged ICU stay, post operative pulmonary complication and mortality were analysed. ***Methods:*** *Patient data who underwent both elective and emergency surgeries were collected from 1st January 2022 to 31st March 2022 during Omicron wave in Kingdom of Bahrain were collected and analysed. Relevant data of patient were collected along with vaccination details, including, type of vaccination, number of doses received and number of booster doses.* ***Results:*** *Of the 81 patients who underwent major surgery, 12 were COVID positive and 69 were negative. Patients who were admitted to ICU admission (OR = 0.91 95% CI = (0.26-3.12) P = 0.88) , patients who underwent post operative ventilation (OR = 0.92 95% CI = (0.26 - 3.21) P=0.90) and mortality (OR = 0.47 95% CI = (0.056 - 4.09) P=0.50) were not significantly different between COVID positive and negative patients .Similarly, those who underwent emergency surgery, 46/419 patients were COVID positive. Patients who were admitted to ICU admission (OR = 1.68 95% CI = (0.70 - 4.03) P = 0.24) P = 0.88) , patients who underwent post operative ventilation (OR = 1.84 95% CI = (0.72 - 4.73) P=0.20) and mortality (OR = 0.465 95% CI = (0.006 - 3.58) P=0.46) were not significantly different between COVID positive and negative patients.* ***Conclusion :*** *In conclusion, patients who underwent elective and emergency surgery during Omicron wave were not associated with significant post operative ICU admission, prolonged ventilation or mortality.*

*Correspondence: Surendranath Venkatesan
Email : drsuren20@gmail.com

https://orcid.org/0009-0001-4016-9957

Received: 11/06/2023
Accepted: 24/01/2024

DOI: https://doi.org/10.4038/slja.v32i1.9226

INTRODUCTION:

SARS - CoV-2 (COVID-19) pandemic, affected global population and it was the topic of major concern in global health and declared as global pandemic since January 2020 by World Health Organisation (WHO). COVID - 19 infection with potential to cause respiratory infection including pneumonia and fatal Adult Respiratory Distress Syndrome is a major risk factor for mortality [1]. Many Variants of Concern (VOC) - like ancestral, Beta, Delta and Omicron with varying disease severity and

community transmissibility was described [2]. Patient characteristics - including age group and vaccination status, symptoms at initial presentation to hospital, oxygen requirement, ICU stay and LOS in hospital were significantly less severe than the previous three waves [3,4] . Age < 5yrs and unvaccinated were most affected during Omicron wave than previous waves. This trend of disease with less severity could be a combination of less virulent strain, immunity with previous infection and vaccine induced immunity [5]. Surgical patients during COVID 19 pandemic posed serious challenges. Elective surgery was delayed and emergency surgery had significant morbidity and mortality and due to the delay the complications related to surgical pathology were severe leading to more surgical interventions [6] . Vaccination against COVID 19, is the most effective and easily available mode to decrease disease transmission and severity. Hence it was advisable to vaccinate elective surgical patients who would benefit the most [7-10] .

Aim of this retrospective study analysed patient characteristics, including impact of pre operative and post operative COVID positive status and vaccination status in patients undergoing surgery during Omicron wave in Bahrain. Other parameters which were analysed were surgical outcome, including prolonged ICU stay, post operative pulmonary complication and mortality.

METHODS:

The study protocol was reviewed and approved by Institutional Review Board of King Hamad University Hospital, Kingdom of Bahrain.

Study design:

For this retrospective observational analysis, patient data who underwent both elective and emergency surgeries were collected from 1st January 2022 to 31st March 2022 coinciding Omicron wave in Kingdom of Bahrain were collected from hospital electronic HOPE system. Patient details collected included preoperative COVID PCR results, post operative COVID PCR results, type and nature of surgery & anaesthesia. Surgical procedures were classified into major, intermediate and minor surgery (Annexure - 1). Any surgical procedure requiring anaesthesia services were also included and such collected data was analysed. Vaccination details was collected from electronic data including, type of vaccination, number of doses received and number of booster doses were noted. Patients who tested positive within 7 weeks of surgery and 14 days after surgery were collected and analysed.

RESULTS :

Between 1st January 2022 to 31st March 2022, totally 2008 surgical procedures were done, both elective and emergency. Anaesthesia techniques included general anaesthesia, neuraxial block, nerve block & monitored anaesthesia care. Of the total 2008 procedures, 914 (46%) were males, and 1094 (54%) were females. 1022 (61%) patients belonged to the age group 16yrs to 60 years. Extremes of age < 5yrs and > 80 yrs were 8% and 2% respectively (Table 1).

Table 1: *Gender and age group distribution of patients.*

Month	Gender Distribution		Age Group					
	Male	Female	0-5 yrs	6 - 15 yrs	16 – 40 yrs	41 – 60 yrs	61- 80 yrs	> 80 yrs
January	290	392	48	25	244	178	172	15
February	268	299	43	21	209	138	141	15
March	356	403	65	38	266	187	197	6
	914 (46%)	1094 (54%)	156	84	719	503	510	36
Total	2008							
			8%	4%	36%	25%	25%	2%

During the study period, majority were elective procedures. 1589 (79%) of 2008 were elective and remaining 419 (21%) were done on emergency basis. 4% (82/2008) of the total procedures were major surgery, remaining 999 (50%) and 927 (46%) were of minor and intermediate surgeries respectively. Anaesthesia techniques included general anaesthesia in 1437 (71.5%) surgeries and 252 (12.5%) & 234 (11.6%) were spinal anaesthesia and local anaesthesia techniques respectively. Majority of procedures were done under general anaesthesia (Table 2).

Table 2: *Representing nature (elective / emergency), type of surgery (minor, intermediate or major) and mode of anesthesia administered to all patients.*

Month	Nature of surgery		Type of surgery			Mode of Anesthesia						
	Elective	Emergency	Minor	Intermediate	Major	GA	Spinal	Epidural	Local	Sedation	Nerve Block	MAC
Jan	540	142	351	309	22	483	91	3	75	27	3	0
Feb	423	144	251	284	32	411	66	4	70	15	0	1
Mar	626	133	397	334	28	543	95	0	89	32	0	0
Total	1589	419	999	927	82	1437	252	7	234	74	3	1
	79%	21%	50%	46%	4%	71.5%	12.5%	0.3%	11.6%	4%	0.1%	0.04%

1589 (79%) patients had already received vaccination against COVID 19. Vaccine against COVID 19 in Kingdom of Bahrain was very high, this pattern reflected in the representative population in the study. 97% of them completed their primary schedule with 2 doses. 1st booster dose was administered in 96% of patients who underwent surgery. Of this 1589 patients who were vaccinated, 54% received vaccination of different vaccine combinations and 46% received same vaccine combination (Table 3).

Table 3: *Vaccination details - vaccine combination, primary dose and booster dose received.*

Month	Vaccination Details		Vaccination Combination		Primary schedule Dose		Booster dose	
	Yes	No	Different	Same	Dose 1	Dose 2	Dose 1	Dose 2
Jan	559	123	310	249	19	540	427	14
Feb	467	100	230	237	8	459	361	14
Mar	565	194	318	247	19	546	434	26
Total	1591	417	858	733	46	1545	1222	54
	79%	21%	54%	46%	3%	97%	96%	4%

Preoperative COVID RT PCR was mandatory in all elective surgery at King Hamad University Hospital. Emergency surgery was accepted with negative Rapid antigen test and followed up with RT PCR confirmation. Elective procedures with pre operative COVID positive status was found in 48% of patients between 21 - 49 days. Same day COVID positive was found in 3% of patient s and all patients presented for emergency surgery. 9% and 40% patients had positive COVID status between 0-14 and 15 - 30 days respectively. 83% of patients who were already vaccinated and 17% in unvaccinated group had pre operative COVID 19 positive status respectively. Of those who were COVID positive and vaccinated 45% and 37% of patients received different and same vaccine combinations (Table 4).

Table 4: *Vaccination details of preoperative COVID positive patients.*

Month	Preoperative COVID positive status				Preoperative COVID Positive cases		Preop COVID positive patients vaccination details		Vaccine combinations		
	Same day	0 – 14 days	15 – 30 days	21 – 49 days	Male	Female	Vaccinated	Unvaccinated	Different	Same	No vaccine
Jan	4	1	2	1	4	4	6	2	3	3	2
Feb	2	12	38	20	34	38	67	5	36	31	5
Mar	0	5	39	74	68	50	91	27	51	40	27
Total	6	18	79	95	106	92	164	34	90	74	34
	3%	9%	40%	48%	54%	46%	83%	17%	45%	37%	17%

Of total unvaccinated patients who were COVID positive before surgery, 32% were less than 5 years of age, who were excluded from COVID 19 vaccination. 65% patients who were both positive and unvaccinated belonged to age group between 5 to 70 years. 77% of positive cases presented for elective surgeries and 23% had emergency surgery. 74% of those who were COVID positive within 7 weeks of surgery received general anaesthesia. 12/2008 (0.59%) patients who were positive within 7 weeks pre operative period, had major surgery and 92% of them received general anaesthesia and remaining 8% received spinal anaesthesia (Table 5).

71 patients tested positive for COVID 19 post surgery. 30% and 70% of patients were positive between 0-7 & 7 - 14 days respectively. There was no difference in male and female populations. Of those who were positive after surgery, 70% of them were vaccinated. Of those who were vaccinated and COVID positive post surgery, 42% of them received different vaccine combinations and 28% received same vaccine combination (Table 6).

Table 5: *Unvaccinated patient details - including patient age, preoperative COVID status, nature of surgery and mode of anesthesia. Patients who underwent major surgery and type of anesthesia in positive cases.*

Month	Pre operative COVID positive patients unvaccinated Age group			Nature of surgery in pre op COVID positive patients		Mode of anesthesia				Major Surgery	Type of anesthesia in major cases in positive patients	
	0 – 5 YRS	5 – 70 yrs	> 70 yrs	Elective	Emergency	GA	Spinal	Sedation	LA	Pre operative positive	GA	Spinal
January	0	2	0	3	5	3	3	0	2	1	0	1
February	1	3	1	54	18	32	8	0	2	5	5	0
March	10	17	0	95	23	91	14	5	8	6	6	0
Total	11	22	1	152	46	147	25	5	21	12	11	1
	32%	65%	3%	77%	23%	74%	13%	3%	11%		92%	8%

Table 6: *Vaccination details of post operative COVID positive patients.*

Month	Post operative COVID positive status		Post operative COVID Positive cases		Post op COVID positive patients vaccination details		Post operative COVID positive Vaccine combinations		
	0 – 7 days	7 – 14 days	Male	Female	Vaccinated	Unvaccinated	Different	Same	No vaccine
January	7	36	24	19	34	9	20	14	9
February	7	10	6	11	9	8	6	3	8
March	7	4	5	6	7	4	4	3	4
Total	21	50	35	36	50	21	30	20	21
	30%	70%	49%	51%	70%	30%	42%	28%	30%

63% of patients who turned positive for COVID, post surgery belonged to 0 - 5 years age group. 77% of them were operated electively and 63% received general anaesthesia. None after major surgery turned positive post surgery (Table 7).

Table 7: *Postoperative COVID positive patients - nature of surgery and mode of anesthesia.*

Month	Post operative COVID positive patients unvaccinated Age group			Nature of surgery in pre op COVID positive patients		Mode of anesthesia				
	0 – 5 YRS	5 – 70 yrs	> 70 yrs	Elective	Emergency	GA	Spinal	Sedation	LA	Epidural
January	6	3	0	34	9	27	7	3	6	0
February	1	2	0	11	6	10	0	1	5	1
March	3	1	0	10	1	8	1	1	1	0
Total	10	6	0	55	16	45	8	5	12	1
	63%	38%	0	77%	23%	63%	11%	7%	17%	1%

/

Table 8 - *Data analysis of patients who underwent major surgery during study period.*

No of patients underwent major surgery	81	ICU Admission (42/81)	Post operative Ventilation (35/81)	Mortality (12/81)
Covid positive	12	6	5	1
Covid Negative	69	36	30	11
		OR = 0.91 95% CI = (0.26-3.12) P = 0.88	OR = 0.92 95% CI = (0.26 - 3.21) P=0.90	OR = 0.47 95% CI = (0.056 - 4.09) P=0.50

Of the 81 patients who underwent major surgery, 12 were COVID positive and 69 were negative. Statistical analysis of data of patients who were admitted to ICU admission (OR = 0.91 95% CI = (0.26-3.12) p = 0.88), who needed post operative ventilation (OR = 0.92 95% CI = (0.26 - 3.21) p = 0.90) and mortality (OR = 0.47 95% CI = (0.056 - 4.09) p =0.50) were not significantly different between both groups (Table 8).

Table 9 - *Data analysis of patients who underwent emergency surgery during study period*

No of patients underwent emergency surgery	419	ICU Admission (43/419)	Post operative Ventilation (34/419)	Mortality (18/419)
Covid positive	46	7	6	1
Covid Negative	373	36	28	17
		OR = 1.68 95% CI = (0.70 - 4.03) P = 0.24	OR = 1.84 95% CI = (0.72 - 4.73) P=0.20	OR = 0.465 95% CI = (0.006 - 3.58) P=0.46

Those patients who underwent emergency surgery, 46/419 patients were COVID positive. Statistical analysis of data of patients who were admitted to ICU was (OR = 1.68 95% CI = (0.70 - 4.03) p = 0.24) p= 0.88), patients who underwent post operative ventilation (OR = 1.84 955 CI = (0.72 - 4.73) p = 0.20) and mortality (OR = 0.465 95% CI = (0.006 - 3.58) p = 0.46) were not significantly different between two groups (Table 9).

DISCUSSION :

SARS-CoV-2 (COVID-19) infection was first reported in Wuhan, China in December 2021. It was declared by World Health Organisation (WHO) as a global pandemic in January 2020. Since then COVID - 19 presented as multiple waves of infection with several Variants of Concern (VoC) viz Alpha, Beta, Delta and Omicron. Each wave has different characteristic spread and infectivity. Omicron variant is responsible for fourth wave.

Different characteristics of each wave, including ease of transmissibility, severity of infection and mortality depend on multiple factors like, virulence of virus strain, co morbidities in population, age, immune response in population - both due to previous infection and vaccine induced. Surgical population, both elective and emergency were highly affected and it led to either delay or cancellation of treatment. Patients surgical conditions worsened due to this

and presented with more surgical complications.

Various societies issued guidelines to manage patients during COVID 19 pandemic. American Society of Anaesthesiologists (ASA) and American Patient Safety Foundation (APSF) had published guidelines time to time to guide clinicians to decide [11]. Association of Anaesthetists published guidelines for patient management during Omicron wave [12]. It was suggested that the decision for elective surgery must be on the basis of urgency of surgery, severity of COVID symptoms and patient co morbidities. For emergency surgery, appropriate personal protective equipments (PPE) must be donned by medical personnel during and after surgery to reduce hospital staff infection. Further, actively infected surgical patients must be admitted in isolation ward separated from other non COVID inpatients.

First case of Omicron was reported in Kingdom of Bahrain on 11th December 2021. Since then infection spread and progressed as a wave with peak infective rates between January and February 2022. The study period included patients presented for elective and emergency surgery during this period from 1st January to 31st March 2022. 2008 patients underwent elective and emergency procedures at King Hamad University Hospital, Kingdom of Bahrain, of which 1589 were elective surgeries and 419 were emergency surgeries.

Omicron infection pattern and patient characteristics were different from earlier delta wave [13]. Hospitalisation rate is very less in Omicron wave comparison to delta wave (41% Vs 69%). Proportion of patients presenting to hospital with severe symptoms requiring oxygen therapy, were less in Omicron wave in comparison to delta wave (31.6% Vs 91.2%) [14] . Mortality in Omicron wave is 2.7% in comparison to delta wave which was 29.1% (d). Asymptomatic infections were more in Omicron wave in comparison to previous waves - 25% Vs 0%) (15). Less virulent virus strain, easy transmissibility and less severe infection along with immunity acquired with previous infection and vaccination resulted in less severe disease during Omicron wave [15].

Patients undergoing surgery with active COVID 19 infection has increased mortality rate (23.6%) [16] with significant difference between asymptomatic patients vs symptomatic patients (5.6% Vs 23.1%). In this study, patients who were infected either before or after the surgery, none reported severe symptoms and none required hospitalisation for COVID infection. Patients requiring post operative ICU admission and ventilation were 71 and 61 patients respectively. COVID positive patients requiring ICU stay were 6 and ventilation were 5 after major surgery which is comparable to non COVID patients (ICU admission 36, Ventilation 30). Patients after emergency surgery requiring ICU admission were 7 and need for invasive ventilation were 6 in comparison to non COVID patients (31 ICU admission and 28 Ventilation). There was no mortality in patient with COVID who underwent major surgery and 1 patient died who underwent emergency surgery.

Patients during delta wave presented with severe symptoms to hospital and need for

oxygen and invasive ventilation was significantly high in comparison to patients presenting to hospital during Omicron wave. ICU admissions and mortality rates were also significantly less during Omicron wave in comparison to previous waves.

All patients undergoing elective surgeries were subjected to RT - PCR for COVID 19 within 72 hours of surgery, if the surgery is deemed urgent or emergency, a Rapid antigen test was done and followed up with RT PCR. Patients were monitored in isolated area till the results of RT PCR were available. According to Association of anaesthetist guidelines, any patient who were positive for COVID-19 before surgery were delayed for 7 weeks unless the surgery is urgent. Surgery was scheduled after discussion with surgical team on the basis of urgency of underlying surgical pathology and severity of previous COVID infection. Association of Anaesthetists recommended postponing surgery for 7 weeks if the surgical treatment can be delayed upto that time. By delaying surgery post operative surgical complications, post operative pulmonary complications were reduced. Where patients (Obstetric, oncology and trauma) need for surgical treatment cannot be delayed or postponed, surgery was done with adequate personal protection equipment.

Patients undergoing major surgeries during delta wave were associated with significant post operative mortality and morbidity. Post operative ICU admission, post operative ventilation and mortality were also significantly increased in patients with active infection than with asymptomatic or recovered patients. In our study patients, were delayed for upto 7 weeks if the surgical treatment can be delayed. AoA recommendation to delay the surgery for 7 weeks post infection during Omicron wave was followed. By delaying surgery, significant inflammatory process associated with COVID infection which may lead to surgical complications were avoided. Patients who required urgent treatment or who had progressive surgical disease were operated with reasonable waiting period as decided in consultation with surgical team. Emergency patients underwent surgery irrespective of their COVID status and were followed up in isolation from separated from other patients in a dedicated COVID isolation ward. Patients with active infection, patients required emergency surgery were not at high risk of post operative ICU admission and post operative ventilation as compared to non infected patients. In comparison to regional anaesthesia, patients who received general anaesthesia were associated with increased rate of post operative pulmonary complications. During regional anaesthesia, patient coagulation status, respiratory status and hemodynamic stability must be considered before deciding on type of anaesthesia. In this study, patients who received both general and regional anaesthesia didn't require post operative ICU admission and prolonged invasive ventilation. In this study major surgical outcomes between COVID infected patients and non infected were not different. Hence, major surgery during Omicron wave did not differ in surgical outcome between patients with COVID infection and uninfected.

Vaccination coverage in Kingdom of Bahrain is 70.2%. Surgical patients vaccination rate was more than the general population

of (79% Vs 70.2%). Of those who underwent surgery, 79% were vaccinated. 97% patients completed their primary vaccine schedule of 2 doses and 96% received booster dose. AoA recommends priority vaccination to patients undergoing surgery. If patient is not vaccinated, it is recommended to encourage the patient to vaccinate at least 4 weeks before scheduled surgery. Vaccination has shown to reduce both surgical complications and mortality rate. Surgical population benefit the most from COVID vaccination due to reduction in severity of COVID 19 infection during preoperative period and complications due to active infection. In this study population, vaccinated and unvaccinated patients showed no difference in ICU admission and post operative invasive ventilation. Hence, vaccination, though it is protective against severe COVID infection and reducing post operative pulmonary complications, vaccination as such did not affect surgical outcome during Omicron wave.

There are many limitations in this study. They are as follows. This is a retrospective study and data collected and analysed were from only one centre. This may not represent trend prevailing in entire country. Patient data, including preoperative, post operative COVID status and vaccination details were retrieved from electronic medical records of the hospital, the time period of follow up is restricted to period of stay in hospital, and further follow up was not done. Of the data totally collected and analysed, genetic details of virus strain infecting each patient is not available. This study lacks details of whether the patients infected were Omicron variants or other variants.

In conclusion, patients who underwent elective and emergency surgery during Omicron wave were not associated with significant post operative ICU admission, prolonged ventilation or mortality. Patients who were infected, surgical treatment must be decided in consultation with surgical team on the basis of surgical urgency, severity of COVID symptoms and patient co morbidity. Vaccination against COVID reduces incidence of severe infection, but does not affect surgical outcome.

REFERENCES:

1. Nanshan Chen et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; 395: 507–13.
2. Raman,R.;Patel,K.J.; Ranjan, K. COVID-19: Unmasking Emerging SARS-CoV-2 Variants, Vaccines and Therapeutic Strategies. *Biomolecules*2021,*11*,993.
3. Araf Y, Akter F, Tang Y-d, et al. Omicron variant of SARS-CoV-2: Genomics, transmissibility, and responses to current COVID-19 vaccines. J Med Virol. 2022;94:1825-1832.
4. Gu B, Yao L, Zhu XY, Zou T, Feng YJ, Yan JY, Zhang JP, Tang PJ, Chen C. Comparison of initial clinic characteristics of hospitalized patients in Suzhou City during the COVID-19 Omicron wave with ancestral variant wave. Ther Adv Respir Dis. 2022 Jan-Dec;16:17534666221110346. doi:

10.1177/17534666221110346. PMID: 35796535; PMCID: PMC9340419.

5. Maslo C, Friedland R, Toubkin M, Laubscher A, Akaloo T, Kama B. Characteristics and Outcomes of Hospitalized Patients in South Africa During the COVID-19 Omicron Wave Compared With Previous Waves. *JAMA.* 2022;327(6):583–584. doi:10.1001/jama.2021.24868

6. Adrian Diaz, Benjamin A. Sarac, Anna R. Schoenbrunner, Jeffrey E. Janis, Timothy M. Pawlik. Elective surgery in the time of COVID-19. American Journal of Surgery; VOLUME 219, ISSUE 6, P900-902, JUNE 01, 2020.

7. Sylvain A. Lother. Preoperative SARS-CoV-2 screening: Can it really rule out COVID-19? Can J Anesth/J Can Anesth (2020) 67:1321–1326.

8. COVIDSurg Collaborative, GlobalSurg Collaborative. SARS-CoV-2 vaccination modelling for safe surgery to save lives: data from an international prospective cohort study. Br J Surg. 2021 Sep 27;108(9):1056-1063.

9. Charlesworth M, Grossman R. Pre-operative SARS-CoV-2 testing, isolation, vaccination and remote prehabilitation - the road to 'COVID-19 secure' elective surgery. Anaesthesia. 2021 Nov;76(11):1439-1441.

10. El-Boghdadly K, Cook TM, Goodacre T, Kua J, Denmark S, McNally S, Mercer N, Moonesinghe SR, Summerton DJ. Timing of elective surgery and risk assessment after SARS-CoV-2 infection: an update: A multidisciplinary consensus statement on behalf of the Association of Anaesthetists, Centre for Perioperative Care, Federation of Surgical Specialty Associations, Royal College of Anaesthetists, Royal College of Surgeons of England. Anaesthesia. 2022 Feb 22. doi: 10.1111/anae.15699. Epub ahead of print. PMID: 35194788.

11. Admin, A. (2022, July 28). *American Society of Anesthesiologists and Anesthesia Patient Safety Foundation Joint Statement on Elective Surgery and Anesthesia for Patients after COVID-19 Infection*. Anesthesia Patient Safety Foundation. https://www.apsf.org/news-updates/asa-and-apsf-joint-statement-on-elective-surgery-and-anesthesia-for-patients-after-covid-19-infection/

12. El-Boghdadly, K., Cook, T. M., Goodacre, T., Kua, J., Denmark, S., McNally, S., Mercer, N., Moonesinghe, S. R., & Summerton, D. J. (2022). Timing of elective surgery and risk assessment after SARS-CoV-2 infection: an update. *Anaesthesia*, *77*(5), 580–587. https://doi.org/10.1111/anae.15699.

13. Jassat, W., Abdool Karim, S. S., Mudara, C., Welch, R., Ozougwu, L., Groome, M. J., Govender, N., von Gottberg, A., Wolter, N., Wolmarans, M., Rousseau, P., Blumberg, L., & Cohen, C. (2022). Clinical severity of COVID-19 in patients admitted to hospital during the omicron wave in South Africa: a retrospective observational study. *The Lancet Global Health*, *10*(7), e961–e969. https://doi.org/10.1016/s2214-109x(22)00114-0

14. Maslo C, Friedland R, Toubkin M, Laubscher A, Akaloo T, Kama B. Characteristics and Outcomes of Hospitalized Patients in South Africa During the COVID-19 Omicron Wave Compared With Previous Waves. *JAMA.* 2022;327(6):583–584. doi:10.1001/jama.2021.24868

15. Gu B, Yao L, Zhu XY, Zou T, Feng YJ, Yan JY, Zhang JP, Tang PJ, Chen C. Comparison of initial clinic characteristics of hospitalized patients in Suzhou City during the COVID-19 Omicron wave with ancestral variant wave. Ther Adv Respir Dis. 2022 Jan-Dec;16:17534666221110346. doi: 10.1177/17534666221110346. PMID: 35796535; PMCID: PMC9340419.

16. COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. Lancet. 2020;396(10243):27–38.