S Afr J Surg. 2023;61:221-231. Online first
https://doi.org/10.36303/SAJS.4061

S Afr J Surg
ISSN 038-2361

TRAUMA

Outcomes of complex burn injury patients managed at two primary and one tertiary level burns facilities in the Western Cape province of South Africa – a retrospective review

SW Carolissen,[1] W Kleintjes,[2,3] F Gool,[4] S Gilbert[5]

[1] *Department of Plastic and Reconstructive Surgery, Stellenbosch University, South Africa*
[2] *Western Cape Adult Provincial Tertiary Burns Unit, Tygerberg Hospital, South Africa*
[3] *Division of Surgical Services, Department of Plastic and Reconstructive Surgery, Faculty of Medicine and Health, Stellenbosch University, South Africa*
[4] *Mitchells Plain District Hospital, South Africa*
[5] *Khayelitsha District Hospital, South Africa*

Corresponding author, email: *stui1184@gmail.com*

Background: This study aimed to compare factors contributing to a positive outcome of adult burn injury patients managed at two primary and one tertiary level Western Cape hospitals. These patients from the primary hospitals (PLHs) met the referral criteria for specialised care at the Tygerberg Hospital burns unit (TBU) but were not accepted or were accepted late.
Methods: A total of 1034 adult burn injury patients seen at two primary level ("A" and "B") hospitals and the TBU between 2016 and 2019 were retrospectively analysed. One hundred and eleven (111) primary level patients ("A" 71, "B" 40) met the criteria for referral to the TBU. The outcomes and factors contributing to positive outcome of these patients were compared with the 859 patients treated at the TBU during the same period.
Results: Patients treated at the TBU showed longer theatre waiting times, more operations, and higher complication and death rates than their primary level counterparts. The PLHs showed no factors significantly contributing to hospital discharge. At TBU, pregnancy status, younger age, hot water burns, lower abbreviated burns severity index (ABSI) score, and longer time to theatre were associated with hospital discharge. A shortage of beds was the main reason for denial of admission to the TBU.
Conclusion: The PLHs showed good outcomes in managing severe burn injuries, although no significant contributors to a positive outcome were identified. Patient- and facility-related factors contributed to positive outcomes at the TBU. Upgrading both the Western Cape's primary level capabilities and the TBU's accessibility and efficiency are necessary to improve burns services.
Keywords: burn injuries, severe burn injuries and management, outcomes of burn injuries, Tygerberg Burns Unit (TBU)

Background

The Western Cape health department stratifies burn management into primary, secondary and tertiary levels of care. Referral criteria for specialised care maximise benefit to the patient and resource allocation.[1–3]

The Tygerberg Hospital burns unit (TBU) is a specialist tertiary centre, catering for adult patients (over 13 years old). The TBU drains all provincial hospitals in the Western Cape and is managed by a plastic surgeon, a senior medical officer, two surgical registrars, and one intern.[4]

Primary level hospitals (PLHs), "A" and "B", are representative of a large proportion of the Cape Western and Eastern subdistrict hospitals respectively. These facilities are similar in size and staff compliment – 2 general surgical consultants, 4 medical officers, and varying numbers of interns. Rode et al. suggested that these facilities be developed to provide higher level burns services in addition to general surgery.[5]

The Western Cape burns referral criteria (Table I) and the abbreviated burns severity index (ABSI) score (Table II) are used as the referral criteria into the TBU.[3,5-7] Unfortunately, many eligible patients are declined admission to the TBU or wait extended periods before being accepted.[4,5] These patients are treated by the PLHs' general surgeons.[4-8] As in other sub-Saharan countries, little is known of the outcomes of these patients.[1,2,4,5,7,9-11] While improved patient outcomes at a specialised burn unit is well-established, outcomes in our setting may not correlate with expectations. Other factors may favour better outcomes at primary level compared to the TBU.[9,12,13]

This study aimed to compare the outcome of this specific subgroup of patients. The secondary aim was to identify and compare the factors contributing to a positive outcome, namely hospital discharge between TBU and the PLHs.

Methods

A retrospective review was conducted of complex (burn injuries that met criteria for level 2 or 3 care) burn injury adult patients, who met the criteria for referral but who were not accepted to the TBU and were managed at two Western Cape PLHs "A" and "B" between 2016 and 2019. Outcomes of these patients were compared to patients treated at the TBU in the same period. The clinical records of all adult burn patients admitted to these facilities were sourced from the electronic continuity of care record (ECCR) and enterprise content manager (ECM). Missing or insufficient data for evaluation from these sources were exclusion criteria.

In collaboration with Stellenbosch University biostatistics department, all descriptive numerical data with normal distributions were described using the mean and standard deviation, whereas non-normal data were described using median and interquartile range. Categorical variables were presented using frequencies (proportions). Chi-squared or Fisher's exact test were used to identify statistical significance for all categorical outcomes. When comparing the continuous data of the two groups, the t-test or the Mann-Whitney U test was used, where appropriate. Logistic regression was used to assess the factors associated with positive outcomes. Statistical significance was set at $p < 0.05$ and a 95% confidence interval was used. All statistical analyses were performed using Stata (V.16, Stata Corp, College Station, Texas, USA) statistical software.

Results

A total of 1034 adults were treated at these facilities during this time period (Table III). One hundred and eleven (111) patients from the primary facilities ("A" 71, "B" 40) met the inclusion criteria. These were compared with all 859 patients treated at the TBU during this study period, of which 812 were given initial burn treatment at a PLH prior to transfer. The remaining 47 patients lived within the Tygerberg Hospital (TBH) drainage area and thus were primarily managed at the TBU.

Demographic and clinical characteristics

At the various facilities, patients differed significantly in terms of 'age' (median "A" 31 (IQR 25–39), median "B" 35 (IQR 28–50) (Table III). This significance was also demonstrated between "A" and the TBU (median 33 (IQR 27–43) ($p = 0.034$). Males predominated at all facilities (Table III).

The prevalence of HIV and hypertension differed significantly between the PLHs and the TBU. These were both more prevalent among the PLH patients ("A" 21%, 3%, "B" 25%, 15%, TBU 11.7%, 11.5%). The prevalence of hypertension was significantly lower at "A" vs both TBU and "B".

Burns causes and severity

Overall, there was no significant difference in either the causes or severity of burns between the primary facilities (Table III). A significant association was found between burn type and level of hospital facility. Facility "A" demonstrated significantly more assault, intimate partner violence and "unknown" causes ($p < 0.001$) than the TBU. Half of all burn injuries at the primary hospitals were accidental injuries. Significant differences were evident across all facilities for the type of burn injury – electrical and flame levels being higher at TBU, "A" demonstrating more hot water burns (HWB) ($p = 0.009$), and "B" having higher chemical, oil, HWB and mixed burn injuries ($p = 0.002$).

No significant differences in percentage total body surface area (% TBSA) burns existed between facility "A" and "B", with 1–20% burns predominating. The TBU showed a significant difference from the PLHs ($p = 0.028$), with more injuries spread across the higher TBSA levels.

In terms of the ABSI score, facility "A" differed significantly to patients treated at the TBU ("A" 5 (IQR 4–6), TBU 6 (4–7), $p = 0.001$), survival probabilities ($p = 0.001$) and threat to life ($p = 0.002$). This was not mirrored by "B" (2 (IQR 2–3) vs TBU, $p = 0.086$). TBU had a significantly higher presence of inhalation injury and ventilated patients than both the primary facilities ($p < 0.001$). These patients were drawn from both those referred in from all lower tier facilities and those who are admitted primarily to the TBU (based on residential address).

Reasons for non-acceptance to the TBU

Table IV shows no significant differences between the PLHs for the reasons for denial of transfer to TBU. 'Shortage of beds' was the most common reason documented. Despite meeting the referral criteria, 19% and 27% of patients from "A" and "B", respectively, were 'not discussed' with the TBU for transfer. Reasons for this were varied and not always documented in the clinical notes. More patients from "A" (19%) were given TBH outpatient burns clinic dates compared to patients from "B" (8%) to offset the limited bed space while the patient was managed at primary level. "B" recorded a higher number of patients (14%) who met the referral criteria for admission to the TBU, but where the TBU doctor (consultant or registrar) on call made the decision that the patient was not for transfer.

From "A" and "B" respectively, 18% and 8% of those initially denied were accepted late for transfer to the TBU (median delay 6 days (IQR 2–8)- and 3 days (3–10) days respectively).

Comparative Management

Of the patients treated at the PLHs, 98.1% received treatment at these facilities, the remaining were palliated (Table V). Management was evenly divided between appropriate dressings and a combination of dressings and surgical debridement (47.6% and 49.5%). Both facilities differed significantly from the TBU in terms of initial management plan, the number of split skin grafts (SSG) (single or multiple) and waiting times for first operation. More than 80% of primary level patients received their procedures within the first seven days with the highest number (39.1%) on day two of hospital stay. The TBU had its single highest number of operations (34.4%) occurring in week two.

While no significant difference was found in terms of the number of single versus multiple operations, the TBU had more patients requiring more than 3 operations.

Patients initially denied transfer were included in the PLH analysis, for reasons for denial. In terms of their outcome, they were included in the TBU cohort as they received definitive management at the TBU. Whether they received initial management at primary level is taken into account in TBU outcome data analysis.

The median length of admission (days) was much lower at the PLHs ("A" 10 (IQR 5–17), "B" 7 (IQR 3–12)) compared to the TBU (17 (IQR 8–35)).

Mortality, morbidity and complications

A higher complication rate was evident at the TBU than at the PLHs (TBU 56.2% vs combined "A" and "B" 39.6%) ($p = 0.015$) (Table VI). In addition, there was a significant difference in final outcomes between these facilities and the TBU (both $p < 0.001$), mainly driven by a higher death rate at the TBU. Overall, only 1.4% and 7.5% of patients died at "A" and "B" respectively (combined "A" and "B" 3.6%), compared to 20.2% at the TBU.

Most complications manifested within the first two weeks of admission, with similar numbers between the second and subsequent weeks. No significant differences existed between primary facilities and the manifestation of complications.

Predictors of positive outcomes (survival and discharge)

Table VII shows predictive factors for discharge from hospital (positive outcome). At the TBU it was found that:

1. Pregnant patients ($n = 8$) had a 37% increase in chance of discharge ($p = 0.029$).
2. Patients with flame burns were less likely to be discharged, with HWB showing 12% increased likelihood for discharge ($p = 0.005$).
3. Patients aged 21 to 40 years were 17% more likely to be discharged ($p = 0.023$).
4. For every unit increase in ABSI score, the chance of discharge fell by 8% ($p = 0.007$).
5. For every category increase in time to theatre (Table V), the chance of being discharged increased by 2% ($p = 0.014$).

There were no factors contributing significantly to a positive outcome at the primary level facilities.

Discussion

The primary aim of this study was to investigate the outcome of severe burns at the PLHs "A" and "B" and compare these with the outcome at the TBU.

The differences in hypertension and HIV levels at the PLHs were possibly due to low comparative numbers of patients. Since 2016, the TBU has not routinely tested for HIV. The hypertensive diagnosis was based on past medical history, not on potentially reactive admission blood pressures.

Half of all burn injuries at the PLHs were 'accidental', suggesting poor fire-safety awareness and behaviour.[4,14]

Up to a third of burn injuries at the PLHs were due to interpersonal violence, with HWB being the associated mechanism at all facilities. Although "B" showed that a third of burns causes was 'unknown', the clinical notes suggested that these were either due to assault or accidental injuries. This reaffirms South Africa's high prevalence of interpersonal, gender-based violence.[15]

Flame injuries predominate as the cause of South African burns at these facilities, similar to other developing countries.[7,16-18] The more severe electrical burns form part of the referral criteria therefore increased the TBU's prevalence.

An expected higher % TBSA scores were found at TBU, contributing the higher ABSI scores. Intubated and ventilated patients were prioritised for early referral, increasing the prevalence of these patients at the TBU.[15] The lower ABSI scores at the PLHs may also explain the delay in acceptance at TBH as more severe cases are likely prioritised. The differences in ABSI and survival index scores were not significant between primary facilities.

The PLHs and the TBU make the diagnosis of airway injury based on clinical suspicion. The availability of a functional bronchoscope is inconsistent (breaking and repair takes years to get it fixed).

The TBU employs stringent criteria for accepting admissions into their unit.[3-7] The data confirmed that the demand for specialised burn care outweighs its capacity.[7] The TBU's limited bed capacity was the main reason for non-acceptance. This restricts the TBU's ability to support the PLHs (similar to most sub-Saharan settings).[1,7,9,16] Alternatively, patients are remotely reviewed using a medical referral app (Vula). Where possible, at TBU consultants' discretion on specific cases, specialist review was done at the TBU outpatient clinic. These patients are inappropriate for both primary and tertiary facilities. The provincial burns referral system names Groote Schuur and New Somerset Hospitals as secondary level facilities for severe burns. These hospitals are far from these PLHs, and their ICUs are often full, limiting their capacity for assistance.

No reason was found for the combined 21% of eligible patients 'not discussed' and therefore not transferred to the TBU for appropriate care. This may represent a mindset among the referring doctors who pre-empt negative responses from the TBU, and that referring certain patients is futile, or otherwise related to local hospital discharge policies, doctor work ethic or (unlikely) policy oversight.

Indicative of their comparable size and resources, time to theatre variables were similar between both PLHs – each able to accommodate 9 patients in absolute numbers in their theatres by day 2 (similar to other Western Cape PLHs).[2,7]

The TBU had more ICU admissions, total operations, complications and longer theatre waiting times than the primary level hospitals, indicating the complexity and severity of the injuries and the clinical conditions of the patients themselves to heal and undergo multiple procedures. Interestingly, there was no significant difference in the number of operations per patient between primary and tertiary levels. Perhaps the faster time to initial operation offset the greater severity of disease accommodated at the TBU. While awaiting theatre, the TBU cohort also had sufficient initial resuscitation, known to improve outcomes.[19]

A meta-analysis of studies done between 1966 through 2004, showed a reduction in mortality with early excision compared to treatment with wound dressing and early grafting. Death rates among those patients without inhalation injury treated with excision were lower than those treated with wound dressing and delayed grafting. Early excision increased blood-transfusion requirements but reduced hospitalisation duration.[20]

Interestingly, longer theatre waiting times at the TBU resulted in an increased likelihood of discharge. This contradicts Gallaher et al., where early access to surgery reduced mortality.[21] Many patients arrive late from the periphery, poorly resuscitated and with deep tissue infections. These conditions necessitate a few days of stabilisation before surgery and then the window for surgery in the first week of arrival is missed due to the limited operating time.

The TBU may differ to other African settings in terms of resource availability. Better pre-operative resuscitation, stabilisation and optimisation prior to operations, better surgical and dressing options at TBU also contributes. In addition, patients requiring immediate surgery were more likely to be in extremis, thus were predisposed to poorer outcomes.

The tendency towards SSG at initial operation at the TBU may indicate optimisation of limited theatre time, or that the patients' clinical condition warranted earlier grafting.

Although the low number of deaths evident at the PLHs limit our analysis thereof, the numbers of deaths are significant. And in keeping with the threat to life score (moderate to moderately severe) given based on the same ABSI scores of 5 at both hospitals (IQR "A" 4–6 (p = 0.001), "B" 5–6 (p = 0.074)) where the expected survival rate is 80–98%.

The higher mortality and complication rate at the TBU was expected and attributed to the combination of higher admission numbers, the complexity of the injuries and conditions of these patients. These differences were mainly driven by blood transfusion rates, bacteraemia and wound sepsis (similar to other burn management centre studies).[7,16,22,23] Factors such as increased time to theatre, access to theatre, and increased need for airway interventions also affected outcomes.

Despite these complications, all facilities discharged more than 70% of their patients. From the TBU, these discharges were in addition to those referred down to primary level, those requiring another medical department intervention, or those refusing further treatment or absconding. More severe injuries are found at the TBU, thus the expected longer admission duration there.

Multiple studies found that sex, age, % TBSA and time to theatre affect patient outcomes.[24-26] No significant contributing factors to hospital discharge were identified at the primary level. Sample sizes, shorter hospital admissions (thus less opportunities for complications) at these facilities may have contributed to these results.

The impact of HIV infections in severe burns patient outcomes is not clearly defined.[15] The significant difference in HIV prevalence between the PLHs and TBU did not contribute significantly to a poor outcome (complications or death) in this analysis.

The small numbers of pregnancies at the TBU (all discharged) likely skewed the result in a favourable light.

Flame burns at the TBU are the single leading cause of complicated burns injuries, due to being the single majority cause of burn injuries. The mostly superficial HWB were more likely to be discharged (12%). Expectedly, the medically fitter 21- to 40-year-old age group was the most likely to be discharged.[15] The median ages of 31 and 35 years at "A" and "B" respectively is in keeping with the literature that the young, more active working age-group is more likely to engage in risk seeking behaviour.

Our data suggests that for every unit decrease in the ABSI score, the chances of being discharged increase by 8%, in keeping with previous studies identifying predictors of poor outcomes at the TBU.[9]

Conclusion

The PLHs analysed fared well in managing severe burn victims who warranted tertiary level admission during this time period. Compared to the TBU cohort, primary level patients had shorter admissions and time to theatre, and lower complication rates. That said, no statistically significant contributors to a positive outcome were identified in the primary level cohort. Prospective documentation could improve monitoring of primary level burn injury outcomes.

The comparatively poorer outcomes found at TBU may be due to a combination of higher numbers, more complex injuries (higher ABSI scores), managed by a smaller team with less access to theatre. These factors have directly impacted on the efficiency of burn services at the TBU and caused a ripple effect on lower tiered hospitals. The PLHs are not equipped with adequate resources to manage severe burns. Although the overall data from the PLHs appear good for the study period it does not reflect the surgeon frustrations at primary level of dealing with a higher ABSI score burn while awaiting admission to the TBU. Upgrading primary level facilities in terms of staff, wound care resources and infrastructure may lessen the burden on the TBU and improve the efficiency of burn care at these hospitals.

Considering the high demand for tertiary services, improving access to the TBU through increased number of beds and permanent staff, will improve tertiary outcomes and better support the lower tier facilities in the Western Cape.

Appendix

Table I: Burns referral criteria as used by the Western Cape health department and the TBU
Table II: Abbreviated burns index score
Table III: Burns causes and severity
Table IV: Reasons for non-acceptance to the TBU
Table V: Comparative management
Table VI: Mortality, morbidity and complications
Table VII: Predictors of positive outcome (survival and discharge)

Conflict of interest

The authors declare no conflict of interest.

Ethical approval

Ethics approval was obtained from the Stellenbosch University Health Research Ethics Committee (HREC) (ref no: S21/05/082) and permission to conduct the study was granted by the Western Cape Department of Health.

ORCID

SW Carolissen https://orcid.org/0000-0002-0227-2291
W Kleintjes https://orcid.org/0000-0002-4402-208X
F Gool https://orcid.org/0000-0003-4116-0943
S Gilbert https://orcid.org/0000-0003-0656-2162

REFERENCES

1. Nthumba PM. Burns in sub-Saharan Afric: A review. Burns. 2016;42(2):258-66. https://doi.org/10.1016/j.burns.2015.04.006.
2. Allorto N, Rencken CA, Wall S, Pompermaier L. Factors impacting time to surgery and the effect on in-hospital mortality. Burns. 2021;47(4):922-9. https://doi.org/10.1016/j.burns.2020.09.002.
3. Rhode H, van der Merwe A, Fourie S, Millar A. Western Cape Government, Health Circular H62 of 2011. Circular H26 of

2011 Republic of South Africa: Western Cape Department of Health; 2011.
4. Rode H, Cox SG, Numanoglu A, Berg AM. Burn care in South Africa: a micro cosmos of Africa. Pediatr Surg Int. 2014;30(7):699-706. https://doi.org/10.1007/s00383-014-3519-5.
5. Rode H, Rogers AD, Numanoglu A, et al. A review of primary and secondary burn services in the Western Cape, South Africa. S Afr Med J. 2015;105(10):853-7. https://doi.org/10.7196/SAMJnew.8187.
6. Kleintjes W, Groote SH. Burns-Referral Criteria/Guidelines [Internet]. UCT, Dept. of Surgery. [Cited 2020 Oct 14]. Available from: https://emguidance.com/discover/Burns-Referral Criteria/Guidelines.
7. Blake N, Swart O, Duvenage RC. The demographics and outcomes of burn patients admitted to Worcester Hospital. S Afr J Surg. 2020;58(2):106A-106D. https://doi.org/10.17159/2078-5151/2020/v58n2a3124
8. Kingu H, Mazwai E. A review of burn care at an emerging centralised burns unit. S Afr J Surg. 2010;48(2):53-8.
9. Boissin C, Wallis LA, Kleintjes W, Laflamme L. Admission factors associated with the in-hospital mortality of burns patients in resource-constrained settings: A two-year retrospective investigation in a South African adult burns centre. Burns. 2019;45(6):1462-70. https://doi.org/10.1016/j.burns.2019.03.005.
10. Muangman P, Sullivan SR, Honari S, et al. The optimal time for early excision in major burn injury. J Med Assoc Thai. 2006;89(1):29-36.
11. Ringo Y, Chilonga K. Burns at KCMC: Epidemiology, presentation, management and treatment outcome. Burns. 2014;40(5):1024-9. https://doi.org/10.1016/j.burns.2013.10.019.
12. Van der Merwe E. Critical care of burn patients in developing countries: cost versus need. Continuing Medical Education. 2008;26(9):428.
13. Davies MR. South African Burn Society Conference 10-12 November 2011, Cape Town. Wound Healing South Arica. 2011;4(2):104-22.
14. Scheven D, Barker P, Govindasamy J. Burns in rural KwaZulu-Natal: Epidemiology and the need for community health education. Burns. 2012;38(8):1224-30. https://doi.org/10.1016/j.burns.2012.04.001
15. Cloake T, Haigh T, Chesire J, Walker D. The impact of patient demographics and comorbidities upon burns admitted to Tygerberg Hospital Burns Unit, Western Cape, South Africa. Burns. 2017; 43:411-6. https://doi.org/10.1016/j.burns.2016.08.031.
16. Den Hollander D, Albert M, Strand A, Hardcastle TC. Epidemiology and referral patterns of burns admitted to the Burns Centre at Inkosi Albert Luthuli Central Hospital, Durban. Burns. 2014;40(6):1201-8. https://doi.org/10.1016/j.burns.2013.12.018.
17. Daffue B, Moolman D, Ferreira S, et al. The causes of burn wounds among adult patients treated at Pelonomi Tertiary Hospital, Bloemfontein. S Afr J Surg. 2018;56(3):31-6. https://doi.org/10.17159/2078-5151/2018/v56n3a2592.
18. Tripathee S, Basnet SJ. Epidemiology of burn injuries in Nepal: a systemic review. Burns Trauma. 2017;5:10. Erratum in: Burns Trauma. 2017;5:15. https://doi.org/10.1186/s41038-017-0081-0.
19. Tan HMG, Chung L, Chong XY, Joethy J, Chong SJ. A simple mnemonic, B.U.R.N.S., for burns first aid. Burns. 2022;48:841-5. https://doi.org/10.1016/j.burns.2021.11.013.
20. Ong Y, Samuel M, Song C. Meta-analysis of early excision of burns. Burns. 2006;32:145-50. https://doi.org/10.1016/j.burns.2005.09.005.
21. Gallaher JR, Banda W, Robinson B, Purcell LN, Charles A. Access to operative intervention reduces mortality in adult burn patients in a resource-limited setting in Sub-Saharan Africa. World J Surg. 2020;44(11):3629-35. https://doi.org/10.1007/s00268-020-05684-y.
22. Giaquinto-Cilliers M, Surgery P, Hoosen M, Officer M. Bacteriological profile at Kimberley Hospital Burns Unit: a four-year retrospective study. Wound Healing South Arica. 2014;7(1):29-32.
23. Brusselaers N, Monstrey S, Vogelaers D, Hoste E, Blot S. Severe burn injury in Europe: a systematic review of the incidence, aetiology, morbidity, and mortality. Crit Care. 2010;14(5):1-12. https://doi.org/10.1186/cc9300.
24. Murhula GB, Musole PB, Kafupi Nama B, et al. Factors associated with outcomes after burn care: a retrospective study in Eastern Democratic Republic of Congo. J Burn Care Res. 2022;43(1):85-92. https://doi.org/10.1093/jbcr/irab051.
25. Stenhoff A, Steadman L, Nevitt S, et al. Acceptance and commitment therapy and subjective wellbeing: A systematic review and meta-analysis of randomised controlled trials in adults. J Contextual Behav Sci. 2020;105398. https://doi.org/10.1016/j.jcbs.2020.08.008.
26. Mehta K, Arega H, Smith NL, et al. Gender-based disparities in burn injuries, care and outcomes: A World Health Organization (WHO) Global Burn Registry cohort study. Am J Surg. 2022;223(1):157-63. https://doi.org/10.1016/j.amjsurg.2021.07.041.

Appendix available online at http://sajs.redbricklibrary.com