Original Article

Enhanced recovery after elective spinal surgery: an Australian pilot study

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Background: The principles of enhanced recovery after surgery (ERAS) aim to reduce the physiological stress of surgery which in turn improve clinical and health economic outcomes. There is ample evidence in literature supporting ERAS methodologies in other surgical specialties, but its adoption in spinal surgery, especially in Australia remains in infancy. The aim of this project is to describe the early experience with an evidence-based ERAS pathway for simple spine surgery, a first of its kind in Australia.

Methods: An ERAS protocol was designed using an evidenced-based review of the literature. The authors then conducted a prospective cohort analysis looking at outcome of patients undergoing elective spinal (lumbar and cervical) decompression surgery under ERAS principles by a single surgeon on the Westmead Hospital Campus between March 2021 to May 2023. Primary outcomes were patient length of stay (LOS), patient reported pain and disability scores and complications (including readmissions within 30 days and re-operation within 6 months). Secondary outcomes included predictors of failure for same-day discharge.

Results: A total of 52 patients underwent spinal decompression surgeries under the ERAS protocol. Overall 43 out of 52 patients (83.7%) were successfully discharged on the same day as their surgery. Patient reported outcomes were improved at 6 weeks and 6 months confirming durability of intervention. The rates of complications were similar to literature reported rates for simple lumbar or cervical decompression procedures and there were no readmissions within 30 days or re-operations within 6 months of surgery. Being of non-English speaking background [odds ratio (OR) =6.08, P=0.04] and from home alone (OR =10.25, P=0.03) were predictors of failure of same day discharge in this small cohort.

Conclusions: Implementation of ERAS protocols for simple spinal decompression surgeries is feasible and produces durable improved patient outcomes while reducing LOS in hospitals. Patient social factors can be predictive of lack of compliance.

Keywords: Enhanced recovery after surgery (ERAS); spine surgery; clinical outcomes

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Introduction

Since its inception in the 1990s (1), enhanced recovery after surgery (ERAS) protocols have emerged to reduce the physiological stress of surgery to improve patient and health economic outcomes. It does so by applying multimodal and interdisciplinary perioperative care

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Table 1 Inclusion and exclusion criteria

Inclusion criteria	
	Age: 18–80 years
	1- or 2-level cervical or lumbar decompression surgery (microdiscectomy, laminectomy, foraminotomy)
	Ability to understand and participate in the program
Exclusion criteria	
	Deemed not suitable by anaesthetic/surgical teams
	Patients with neurological deficit requiring inpatient rehabilitation

to reduce physiological stress of surgery and maintain homeostasis (2). Coordination and engagement among multiple teams (anaesthetic, surgical, allied health staff, nursing) and patients is paramount to deliver a unified and iterative approach to the patient's journey at a high level of quality. As such, the ERAS® society (www.erassociety.org) has developed evidence driven guidelines for the successful implementation and audit of these perioperative pathways in various specialties. Although its roots began in colorectal surgery multiple surgical fields such as cardiothoracic (3), gynaecology (4) and orthopaedic joint surgery (5) have applied speciality-specific protocols with published successes over the last decade. More recently its implementation and assessment has been adopted to spine surgery across the world, but in Australia it still remains in its infancy.

Considering the recent coronavirus disease 2019 (COVID-19) pandemic, its crippling burden on our hospitals and generation of a massive elective case backlog (6,7), strategies to reduce inpatient admissions and cancelled elective surgeries due to bed and staff shortages are paramount. These strategies also need to address minimising the physiological impact of surgery on our aging global population with an increasing burden of disease caused by spinal pathologies (8). The ERAS paradigm aims to achieve this by minimising the physiological, psychological and social stress that surgery places on each patient, thus reducing LOS and hospitalisation costs without increasing complications or readmissions (9-13). This study aims to provide early experience at a single institution in Australia in implementing ERAS protocols in simple spinal surgery (1- or 2-level laminectomy, discectomy or decompression), with a focus on identifying factors that would predict failure. It aims to serve as a steppingstone for implementation, evaluation, and iterative improvement of ERAS protocols in spine. We present this article in accordance with the STROBE reporting checklist (available at https://jss.amegroups.com/article/view/10.21037/jss-23-115/rc).

Highlight box

Key findings

- The study demonstrates the feasibility and safety of implementing enhanced recovery after surgery (ERAS) principles in decompressive spinal surgeries without compromising on patient outcomes up to 6 months post-surgery.
- Being of non-English speaking background and from home alone were predictors of failure of same-day discharge in our cohort.

What is known and what is new?

- ERAS principles across various surgical specialties have delivered patient optimization through their surgical journey resulting in improvement in patient and health economic outcomes.
- This study is a first of its kind in Australia and gives insight into predictors of failure in this cohort.

What is the implication, and what should change now?

- ERAS methodology for spinal surgery should be embraced across Australia to reduce burden on hospitals without increasing patient complications.

Methods

Study design

This study is a prospective cohort analysis of suitable consecutive patients, to demonstrate the feasibility of implementing and actioning an ERAS protocol for patients undergoing simple spine surgery by a single neurosurgeon (Y.L.) at Westmead Public and Private Hospitals. The protocol was implemented by March 2021 with the first patient being enrolled in that month and the final patient in May 2023. Inclusion and exclusion criteria have been detailed in *Table 1*. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). It was

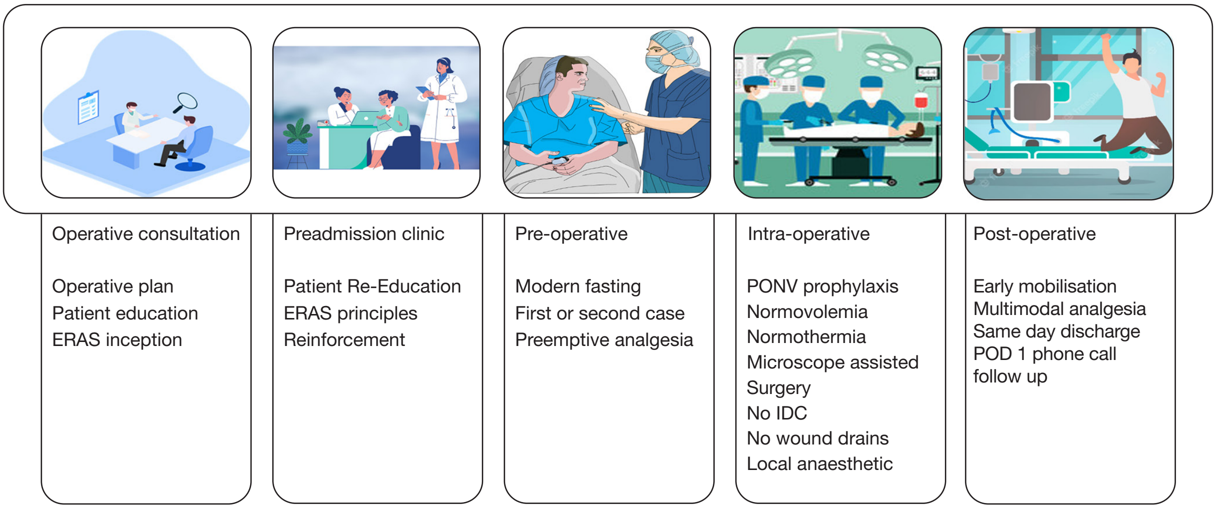

Figure 1 Westmead ERAS protocol. ERAS, enhanced recovery after surgery; PONV, postoperative nausea and vomiting; IDC, in-dwelling catheter; POD, postoperative day.

deemed to be of negligible risk according to the National Statement on Ethical Conduct in Human Research (14) and granted an exemption by the Western Sydney Local Health District Human Research Ethics Committee with individual consents waived.

ERAS protocol

The last few years have seen an increase in publications for implementation of ERAS protocols in the neurosurgical arena (15-22). The ERAS® society has also recently published a consensus statement for perioperative care in lumbar spinal fusion requiring a multidisciplinary team including surgeons, anaesthesiologists, nursing staff, physiotherapists, social services and hospital administration for successful implementation and audit (23). Our ERAS protocol has taken inspiration from these publications and guidelines and is divided into five distinct chronological periods detailing a spinal patient's operative journey (*Figure 1*). The components of each of these will be reviewed here.

Once a patient meets the inclusion criteria, they undergo a detailed discussion and informed consent regarding their planned operative procedure during their operative consultation with a medical member from the neurosurgical team. At this time, they are also introduced to the idea of ERAS principles—minimally invasive surgery, immediate mobilisation with multimodal analgesics and same day discharge. This also allows for the patient to be pre-optimised from a physical and functional status by assessing, educating and referring them (if indicated) for better diabetes control, nutritional supplementation, smoking cessation and narcotic/alcohol use.

During the preadmission clinic, these principles are reiterated, and their expectations are set to encourage their own initiative and motivation for recovery postoperatively. Preoperatively, the patients are advised to fast as per modern fasting guidelines (24) and receive preemptive analgesia (200 mg celecoxib, 75 mg pregabalin and 1 g of paracetmol) (25,26) when they are checked in on the morning of their surgery.

The surgery is performed under general anaesthesia with infiltration of a weight based maximal dose of bupivacaine with adrenaline (0.25%)—half delivered pre-incision and half at wound closure. Intraoperatively they receive 1 mg/kg oxycodone, 10–20 mmol Magnesium sulfate (27) and 2 mcg/kg clonidine (28) for intraoperative comfort and opioid sparing post-operative analgesia. The surgery is performed with the assistance of an operating microscope employing minimally invasive techniques such as unilateral laminectomy for bilateral decompression. Foley catheters or wound drains are not used. Goal directed fluid management and convective warming devices are adopted. Eight mg of dexamethasone was administered at time of induction for post operative nausea and vomiting (PONV) prophylaxis.

Post-operatively, opioid sparing multimodal analgesia (regular paracetamol, regular celecoxib with tapentadol PRN as required) is provided as a script at time of discharge. The patient is assessed by the physiotherapy

Table 2 Patient characteristics and procedural specifics

Characteristic	Value
Demographic	
Age, years, mean ± SD	49.2±14.3
Female sex, n [%]	18 [35]
BMI >30 kg/m^2, n [%]	26 [50]
Preoperative narcotic use, n [%]	11 [21]
Current smoker, n [%]	18 [35]
ASA, n [%]	
1	8 [15]
2	36 [69]
3	8 [15]
Blood thinners, n [%]	5 [10]
Psychiatric history, n [%]	10 [19]
Social, n [%]	
Non-English speaking background	9 [17]
At home alone	5 [10]
Rural residence	7 [13]
Procedural, n [%]	
Pre-operative weakness	13 [25]
Operation type	
Cervical	7 [13]
Lumbar laminectomy	5 [10]
Lumbar LRD	11 [21]
Lumbar microdiscectomy	22 [42]
Lumbar ULBD	7 [13]
Multilevel	3 [6]

SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists; LRD, lateral recess decompression; ULBD, unilateral laminectomy and bilateral decompression.

team in post-operative recovery and discharged within 4 hours post-procedure. After discharge the patient was contacted postoperative day 1 (POD 1) via phone call and then reviewed POD 5 in clinic (if local). They then had subsequent routine follow-up at 6 weeks post-operatively.

Study parameters

Primary outcomes included length of stay (LOS), patient reported outcomes (PROs) and complications (readmission within 30 days, post-operative wound infection or any other adverse event that could be attributed to surgery or same day discharge). PROs were measured using Numeric Rating Score (NRS) in conjunction with Oswestry Disability Index (ODI) and Neck Disability Index (NDI) for patients undergoing lumbar surgery and cervical surgery respectively. These questionnaires were filled out by the patient at their pre-operative, 6-week post-operative and 6-month post-operative follow-up appointments. Patient demographics, medical comorbidities and operative parameters were also analysed specifically looking for predictors of failure and/or complications.

Statistical analysis

Descriptive statistics were used to summarise the characteristics of the enrolled cohort. Continuous variables were described using mean and standard deviation and categorical variables were described using counts and percentages. Associations with failed same day discharge were measured using logistic regression for continuous dependent variables. Fisher's exact test was used for categorical dependent variables with any cell counts less than five, otherwise the Chi square test was used. Odds ratios (ORs) were calculated with 95% confidence intervals. A two-tailed alpha of 0.05 was used as the threshold for statistical significance. All analyses were conducted using R version 4.3.0.

Results

A total of 52 patients were enrolled in this pilot study between March 2021 to May 2023. Patient demographics along with social and procedural specifics are summarised in *Table 2*.

Nine of the 52 patients (17.3%) were not successfully discharged on the same day of their operation, with 7 discharging POD 1 and the remaining 2 POD 2. The reasons for these patients' inability to be discharged on the same day are outlined in *Table 3* in chronological order.

The rate of complications in this cohort was 7.7% (4 out of 52) patients. These included 1 patient who had a durotomy, 1 with a wound haematoma, 1 with a superficial wound infection, and 1 presentation to the emergency department with recurrent radicular pain. The patients were all managed conservatively and did not require readmission. One patient had recurrent symptoms at their 12-month

Table 3 Reasons for failed same-day discharge in case chronological order

Case	Reason(s) for failure
1	Last case on operating list, day-only ward closed and unable to accommodate patient
3	Communication breakdown with no transport home
13	Anaesthetist of the day felt strongly that patient needed inpatient monitoring
23	Asymptomatic post-operative hypotension with non-specific ECG changes
25	Rural domicile with no local accommodation
28	Post-operative surgical wound pain
33	Asymptomatic post-operative hypotension
41	Post-operative desaturation due to undiagnosed OSA
43	Post-operative nausea and vomiting, rural domicile

ECG, electrocardiogram; OSA, obstructive sleep apnoea.

Table 4 PROs in patients pre- and post-operatively (6 weeks and 6 months)

Outcome	Pre-operatively	Post-operatively (6-weeks)	Post-operatively (6-months)
NRS for back or neck pain	6.6±2.8	2.7±2.5	3.0±2.9
NRS for leg or arm pain	7.9±2.2	2.1±2.8	3.0±3.4
ODI/NDI	51±20	20±18	27±25

Data are presented as mean ± SD. PRO, patient reported outcome; NRS, Numeric Rating Score; ODI, Oswestry Disability Index; NDI, Neck Disability Index; SD, standard deviation.

follow-up and had a reoperation.

Pre-operative, 6-week post-operative and 6-month post-operative PROs are summarised in *Table 4* and demonstrate an expected improvement in pain and functional scores that were sustained at their 6-month follow-up (P<0.0001).

Patient demographics and procedural specific factors were analysed as associated causes predicting failure of the ERAS protocol and are summarised in *Table 5*. Patient demographics, weight, pre-operative narcotic use, medical comorbidities, and procedure specific factors were not predictors of failure in this cohort of 52 patients. However, if the patient was of non-English speaking background (NESB) (OR =6.08, P=0.04) or was from home alone (OR =10.25, P=0.03), they were more likely to fail the ERAS protocol. Patients with multilevel surgeries, cervical surgeries and unilateral laminectomy and bilateral decompression (ULBD) procedures had no failures and thus ORs could not be calculated.

Discussion

Over the last two decades, various authors have published results in relation to outpatient or same-day discharge operative interventions for degenerative lumbar pathologies without increasing 30-day readmission rates or complications and with significant improvement in pain scores (17,29-31). Although not strictly within an overarching ERAS framework, these studies have proven to be stepping stones to the first proposal of the application of ERAS in major spine surgery by Wainwright *et al.* (15). Since then, ERAS has gained significant momentum into populations undergoing elective spine surgery (16,18-20,32,33). We report the clinical outcomes of the first prospective cohort study from Australia in which an ERAS protocol was implemented for a population of patients that underwent decompressive elective spine surgery and search for predictors of its failure.

Our study demonstrates a success rate of 82.7% (43 out of 52 patients) for same day discharge with no readmissions within 30 days from surgery. The PROs for NRS also show improvements from 6.6 to 2.7 for back/neck pain and 7.9 to 3.0 for leg/arm pain at 6 months post-surgery. The ODI/NDI results were similarly improved from 51 preoperatively to 27 at the 6-month follow-up. These

Table 5 Factors associated with ERAS protocol failure

Characteristic	Success (n=43)	Failure (n=9)	OR (95% CI)	P value
Age, years, mean ± SD	48.0±14.2	55.0±14.3	0.96 (0.91–1.02)	0.18
Female sex, n [%]	14 [29]	4 [44]	1.66 (0.38–7.15)	0.70
BMI >30 kg/m^2, n [%]	21 [49]	5 [56]	1.31 (0.31–5.55)	1.00
Narcotic use, n [%]	10 [23]	1 [11]	0.41 (0.05–3.71)	0.66
Current smoker, n [%]	15 [35]	4 [44]	1.49 (0.35–6.41)	0.71
ASA, n [%]				>0.99
1 (reference)	7 [16]	1 [11]	–	
2	29 [67]	7 [78]	1.69 (0.18–16.06)	
3	7 [16]	1 [11]	1.00 (0.05–19.36)	
Blood thinners, n [%]	3 [7]	2 [22]	3.81 (0.54–27.08)	0.20
Psychiatric history, n [%]	8 [19]	2 [22]	1.25 (0.22–7.19)	>0.99
NESB, n [%]	5 [12]	4 [44]	6.08 (1.21–30.47)	0.04
At home alone, n [%]	2 [5]	3 [33]	10.25 (1.41–74.51)	0.03
Regional or rural residence, n [%]	5 [12]	2 [22]	2.17 (0.35–13.50)	0.59
Pre-operative weakness, n [%]	9 [21]	4 [44]	3.02 (0.67–13.63)	0.20
Region, n [%]				0.33
Cervical (reference)	7 [16]	0 [0]	–	
Lumbar	36 [84]	9 [100]	*	
Type of lumbar operation, n [%]				0.26
Laminectomy (reference)	3 [7]	2 [22]	–	
Midline-preserving procedures	33 [77]	7 [78]	0.32 (0.04–2.27)	
ULBD	7 [16]	0 [0]	*	0.15
Multilevel, n [%]	3 [7]	0 [0]	*	>0.99

*, OR calculation not possible due to 0 failures. OR, odds ratio; CI, confidence interval; SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists; LRD, lateral recess decompression; NESB, non-English speaking background; ULBD, unilateral laminectomy and bilateral decompression; ERAS, enhanced recovery after surgery.

numbers are comparable to other similar studies looking at simple spinal decompressions performed under ERAS principles (16,19,20). Post-operative complication rates in lumbar laminectomies range from 0–15.8% with dural tears, post-operative infection and pain being the most prominent concerns (34). Our complication rate of 7.7%, with none requiring inpatient care or reoperation is comparable to these published results both performed as day cases or as inpatients (35). Overall, our outcomes, albeit in a small population sample demonstrate durability of the surgery performed under ERAS principles without compromising patient care.

Many factors including patient comorbidities, post-operative pain, complications and post operative fear of movement affect LOS in patients undergoing spinal surgery. Through the ERAS framework most of these factors can be addressed at various points in the patient's surgical journey. The inception of early mobilisation from the operative consultation stage, reinforced along subsequent contact points helps in setting expectations and motivating them to enhance their recovery immediately after surgery. This motivation is then reinforced by perioperative multimodal analgesia, minimally invasive surgical techniques, no usage of Foley catheter or wound drains, to minimise the physiological impact of surgery and providing an ideal environment for their recovery.

Analysing various factors that increase likelihood of failure of same-day discharge, we found that being of NESB (OR =6.08, P=0.04) or from home alone (OR =10.25, P=0.03) were the only statistically significant contributors in patients requiring inpatient admission. Although all NESB patients had consultations with healthcare approved telephone interpreter services throughout their ERAS journey, they are more likely to feel like a burden to the medical team and are often embarrassed to admit their inability to understand specifics (36). Culturally, these patients may believe in traditional concepts that longer LOS means better care and recovery (37)—an ideology that may be hard to change over a period of two pre-operative consultations. This ultimately limits these patients' ability to participate in shared decision making and result in non-adherence to the ERAS protocol compared to English-speaking patients. We propose the use of in-person interpreter services in the presence of English-speaking family members or friends to better disseminate the ERAS principles in these patients to reduce their likelihood of failure.

There is ample evidence in literature that patients with disparities among social determinants of health can impact overall wellbeing and surgical outcomes (38,39). Being currently married, having a partner at home and generally having social connectivity with relatives and friends is associated with shorter LOS, 30-day representations and readmissions (39). Our study has also demonstrated that having no family or friends that are able to pick a patient up when they are ready for discharge and stay with them at home is the highest predictor of failed same-day discharge. Although not including patients from home alone is an option to improve ERAS success, other options such as the use of medihotels for patients with no transport home or overnight assistance can also unburden hospitals from unnecessary social admissions.

Body mass index (BMI) >30 kg/m^2 and age >65 years have been demonstrated as predictors of failure of ERAS, particularly in the field of colorectal surgery (40,41). In our small population cohort, neither of these factors reached statistical significance likely due to such small sample size, but also due to the direct impact BMI has on open or laparoscopic colorectal surgery.

Despite the use of minimally invasive surgery (MIS) techniques, certain spinal procedures can be more invasive than others—traditional laminectomies compared to ULBD; single level compared to multilevel. In our analysis, we were unable to demonstrate any relationship between the type of surgery and failure of same-day discharge, but this is likely attributable to small case numbers in each subset of included surgeries.

One of the key benefits of having an iterative ERAS protocol is its ability to adapt and improve over time and be flexible enough to accommodate various patient population demographics. For example, in our study, the first patient failed same-day discharge as the case was done later in the day; this resulted in the modification of the ERAS protocol for patients to be done either first or second on the elective operating list. Similarly, cases cancelled due to disagreement between anaesthetists regarding suitability for discharge on the same day resulted in ensuring patient review in pre-admission clinic by the same anaesthetist that would be involved on the day of surgery.

At its core, ERAS is about improving patient outcomes and speeding up patient recovery by optimising their surgical experience. As per the consensus guidelines by the ERAS® society (23), 22 items have been identified for lumbar fusion looking at every aspect of a patient's journey and promoting the patient as an active participant in their recovery and rehabilitation. This paradigm relies on multidisciplinary and collaborative care of various specialties involved in the patient's surgical journey to engage in a standardised fashion. The incremental benefits of its various elements translate to better patient and health outcomes and demonstrated in multiple systematic reviews (9-13) and are confirmed albeit in a small population in our Australian first study.

There are, however, several limitations to this study. It is prospective cohort analysis which is primarily limited by its small sample size. Randomisation and blinding were not performed due to limited resources and single surgeon involvement, and this introduces a selection bias within our patient population. There were minor deviations from the multimodal opioid sparing analgesic regime depending on the anaesthetist involved which were not well documented and difficult to assess. This pilot study only included patients undergoing simple spinal decompressions using a targeted set of ERAS interventions. Although assessment of nutritional status and pre-operative nutritional optimization form part of ERAS® society spinal fusion guidelines (23), due to resource and personnel limitations, these could not be incorporated into our implemented protocol and should be included in future iterations of the protocol. A larger study population with inclusion of more complex spinal surgeries (such as instrumented fusions and disc replacements) as well randomisation to eliminate selection bias should be considered in future studies.

Despite these limitations, this study demonstrates the safety and efficacy of our ERAS protocol and the feasibility of its implementation without significant overhead. Patient social factors play an important role in same day discharges for simple spinal surgeries and a formalised ERAS pathway allows for better surgical education for patients preoperatively. Such an ERAS protocol can be safely incorporated in other centres across Australia to help reduce burden of inpatient admissions from elective spine surgery whilst improving patient outcomes.

Conclusions

There is strong emerging evidence to support the adoption of ERAS principles across spine surgery to improve LOS, complication rates, post-operative pain and functional outcomes. This is particularly important with increasing demand for spine surgery and increasing burden on our hospital admissions and staff, recently brought to light with the public health crisis during the COVID-19 pandemic. Our study shows that the adoption of such a comprehensive ERAS program in spine surgery is beneficial and simple to apply. It demonstrates the special attention that needs to be placed on social factors and patient understanding, especially in a multicultural and socio-economic diverse population like Australia, to facilitate its success.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jss.amegroups.com/article/view/10.21037/jss-23-115/rc

Data Sharing Statement: Available at https://jss.amegroups.com/article/view/10.21037/jss-23-115/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jss.amegroups.com/article/view/10.21037/jss-23-115/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). It was deemed to be of negligible risk according to the National Statement on Ethical Conduct in Human Research and granted an exemption by the Western Sydney Local Health District Human Research Ethics Committee with individual consents waived.

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