



Article

Surgical Registrars as Primary Operators Have Acceptable Outcomes for Trauma Laparotomy

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Abstract: Background: The literature has suggested that acceptable outcomes in elective general surgery can be achieved with registrars operating but is less clear with trauma surgery. Methods: This was a retrospective study of all laparotomies performed for adult trauma between 2012 and 2020 at a Level 1 Trauma Centre in New Zealand to identify potential differences in clinical outcomes between primary operators. The primary operator of each operation was identified, along with the presence or absence of a consultant and the clinical outcome. Results: During the 9-year study period, a total of 204 trauma laparotomies were performed at Waikato Hospital. The groups of the primary operators were: a registrar with a consultant present (27%), a registrar without a consultant present (22%), a registrar assisting a consultant (48%), and a consultant who operated without a registrar (3%). Direct comparison was made between the three groups where registrars were involved in the laparotomy. There was no significant difference in the clinical outcomes, whether a consultant was present or not. Conclusions: Surgical registrars have acceptable outcomes for trauma laparotomy in the appropriate patients. A consultant surgeon should still operate on patients with more significant physiological derangements.

Keywords: wounds and injuries; laparotomy; general surgery; internship and residency



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1. Introduction

Surgical training remains largely an apprenticeship model during which technical skills are passed between trainers and surgical registrars [1]. A surgical registrar requires long hours of consistent operative surgery and, despite the move towards surgical simulation, is still required to perform a number of surgical procedures to achieve competence [2,3]. The patient safety movement has quite correctly pointed out that this clinical and operative exposure must not be obtained at the expense of patient safety [4]. The concerns surrounding safety are exacerbated by political and social issues surrounding inequality in access to care [5]. As surgical training in New Zealand occurs in public institutions, there is a degree of inherent inequality in that already vulnerable patients have limited choice in terms of the service provider [6]. Trauma surgery is especially egregious. Trauma patients are already in major danger due to the acute nature of their pathology, yet they are also most likely to be operated on after-hours by registrars [7]. The need to train competent surgeons must be balanced against the rights of vulnerable patients to access safe and efficient surgical care. The patient safety movement and the global surgical movement are correct in their concerns [8]. It is important that institutions show parity in outcomes between patients operated on by surgical registrars and by surgical consultants [8]. Furthermore, a recent systematic review suggested the favorable presence of an in-house trauma surgeon 24/7,

based on the more favorable outcomes achieved with in-house trauma surgeons compared to on-call trauma surgeons [9].

This study sets out to compare the outcomes for trauma laparotomies at a major New Zealand trauma centre. It reviews all trauma laparotomies and compares outcomes based on who was present at the initial operation and who the primary operator was. It is hoped that this data will inform the ongoing debate in Australasia about the registrar performance of acute surgical procedures and the appropriate balance between the acquisition of key surgical skills and clinical oversight.

2. Materials and Methods

2.1. Clinical Setting

Waikato Hospital is located in Hamilton, New Zealand. It is a tertiary centre and a university hospital, with the clinical school affiliated to the University of Auckland. It is one of the largest acute hospitals in the country and is the only Royal Australasian College of Surgeons (RACS) certified Level 1 trauma centre in New Zealand. The Waikato District Health Board (WDHB) covers a catchment population of approximately 440,000. It manages approximately 3400 trauma admissions per annum, over 400 of which have Injury Severity Score (ISS) > 12 [10]. The Department of Surgery at Waikato Hospital is a RACS designated training centre certified to conduct specialist training for general surgical registrars within the Surgical Education and Training Programme (SET). The current SET programme lasts five years.

2.2. The Study

This was a retrospective study conducted from 2012 to 2020 and included all primary laparotomies performed for trauma. Only adult cases over the age of 15 were included as the paediatric surgical department managed paediatric trauma. This included all cases of both blunt and penetrating trauma. The demographics, admission physiology, mechanism of injury, and organ injury were documented. The case notes and operative records for each case were reviewed. Determination of the level of registrar and consultant involvement was made from the operative notes. The postgraduate year level (PGY) of each registrar from obtaining a primary undergraduate qualification in medicine or surgery was verified against the public register of doctors held by the Medical Council of New Zealand. A consultant surgeon was an individual who had been awarded a Fellowship of the Royal Australasian College of Surgeons and held a specialist consultant position at our centre. The clinical outcomes of each case were reviewed, being the mean length of hospital stay, mortality and morbidity. This audit was registered with and approved by the WDHB Clinical Audit Support Unit (4142).

To clarify the terminology, a registrar is the equivalent of a resident, and a consultant is the equivalent of an attending compared to North America.

2.3. Statistical Analysis

All relevant data were extracted and initially summarised onto a Microsoft Excel© (Microsoft Corporation, Redmond, WA, USA) spreadsheet for review. All statistical analyses were performed using R (version 4.0.3; R Foundation for Statistical Computing, Vienna, Austria). Data were stratified by groups of the primary operator: a registrar with a consultant present, a registrar without a consultant present, and a registrar assisting a consultant. An additional group, a consultant who operated without a registrar, was documented but was not included in the analysis. Normality of data was investigated using the Shapiro–Wilk test and by graphical inspection. Normally distributed continuous data were reported as the mean $\pm$ standard deviation (SD) and compared using a one-way analysis of variance (ANOVA) test. Categorical data were reported as the frequency (n) and percentage (%) and compared using the Chi-squared or Fisher’s exact test (when $n < 5$). A two-tailed p -value of <0.05 was considered statistically significant.

3. Results

3.1. Overview

During the 9-year study period, a total of 204 trauma laparotomies were performed at Waikato hospital. 82% were for blunt trauma, and the remaining 18% were for penetrating trauma (6% gun-shot wounds and 12% stab wounds). The mean post-graduate year (PGY) level for registrars was 14 years, and the mean injury severity score (ISS) for all three groups was 23. The mean age of patients undergoing a trauma laparotomy was 39 years, 65% of patients were male (132/204), and 35% were female (72/204). The mean physiology at admission was: Heart rate (HR): 98 bpm, Systolic Blood Pressure (SBP): 110 mmHg, Shock index (SI): 1.0, pH: 7.28, Lactate: 3.1 mmol/L, and Base Excess (BE): −4.3. The mortality rate was 5%, the morbidity rate was 37%, and the mean length of stay was 19 days.

3.2. Primary Operator

Of these 204 laparotomies, in 27% of cases, the primary operator was a registrar with a consultant present (55/204). In 22% of cases the primary operator was a registrar without a consultant present (44/204). In 48% (98/204), the registrar was the assistant to the consultant, who was the primary operator. In 3% (7/204), the primary operator was a consultant without a registrar. Direct comparison was made between the three groups where registrars were involved in the laparotomy and are summarised in Table 1.

Table 1. Registrar assisting trainer vs. registrar as primary operator with trainer present vs. registrar as primary operator with no trainer present: mean PGY of the registrar, patient characteristics, and organ injury.

	Registrar Assisting Consultant	Registrar as Primary Operator with Consultant Present	Registrar as Primary Operator with No Consultant Present	p-Value
n (%)	98 (48)	55 (27)	44 (22)	
Mean PGY Level (±SD)	10 (±5)	12 (±5)	14 (±4)	<0.0001 *
Demographics				
Age (±SD)	40 (±19)	38 (±17)	40 (±18)	0.79
Male (%)	60 (61)	35 (64)	31 (70)	
Female (%)	38 (39)	20 (36)	13 (30)	0.85
Physiology (±SD)				
HR	102 (±26)	97 (±25)	89 (±25)	0.02 *
SBP	101 (±27)	118 (±31)	122 (±24)	<0.0001 *
Shock Index	1.1 (±0.5)	0.9 (±0.4)	0.8 (±0.3)	<0.0003 *
pH	7.27 (±0.11)	7.30 (±0.09)	7.30 (±0.12)	0.15
Lactate	3.6 (±2.6)	2.9 (±2)	2.5 (±2.2)	0.025 *
BE	−5.2 (±4.9)	−3.4 (±4.6)	−3.9 (±4.6)	0.06
Mechanism (%)				
Blunt	82 (84)	44 (80)	38 (86)	
Penetrating	16 (16)	11 (20)	6 (14)	0.87
GSW	5 (5)	5 (9)	0 (0)	0.073
SW	11 (11)	5 (11)	6 (14)	0.92
Mean ISS (±SD)	23 (±13)	23 (±15)	23 (±15)	1
Organ Injury (%)				
Diaphragm	13 (13)	5 (9)	3 (7)	0.68
Liver	28 (29)	14 (25)	8 (18)	0.61
Gallbladder	0 (0)	3 (5)	0 (0)	0.0018 ^
Spleen	33 (34)	15 (27)	11 (25)	0.72
Pancreas	4 (4)	2 (4)	1 (2)	1
Stomach	6 (6)	3 (5)	1 (2)	0.82
Small Bowel	33 (34)	18 (33)	15 (34)	1
Large Bowel	33 (34)	12 (22)	13 (30)	0.44
Kidney	4 (4)	3 (5)	1 (2)	0.91
Intra-abdominal vasculature	13 (13)	3 (5)	1 (2)	0.043 ^

Bolded: p-value < 0.05 and is considered statistically significant. * ANOVA test used for statistical analysis.

^ Fisher's Exact Test used for statistical analysis.

3.3. Clinical Outcome

There was no significant difference in the clinical outcomes (morbidity or mortality) whether a consultant was present or not, and these are summarised in Table 2. The consultant was more likely to be present in those with lower SBP, higher SI or higher serum lactate level.

Table 2. Registrar assisting trainer vs registrar as primary operator with trainer present vs registrar as primary operator with no trainer present: Outcome.

	Registrar Assisting Consultant	Registrar as Primary Operator with Consultant Present	Registrar as Primary Operator with No Consultant Present	p-Value
<i>Outcome</i>				
Mean length of stay ($\pm$ SD)	21 ($\pm$ 30)	17 ($\pm$ 14)	16 ($\pm$ 15)	0.41
Mortality (%)	6 (6)	3 (5)	1 (2)	0.82
Morbidity (%)	36 (37)	24 (44)	13 (28)	0.55
Anastomotic Leak	1 (1)	2 (4)	0 (0)	0.36
Respiratory	9 (9)	10 (18)	4 (9)	0.25
Wound	9 (9)	5 (9)	5 (11)	0.98
Renal	4 (4)	1 (2)	2 (4)	0.84
Cardiac	6 (6)	2 (4)	1 (2)	0.82
Gastrointestinal	13 (13)	11 (20)	5 (11)	0.27
Other	5 (5)	5 (9)	4 (9)	0.6

4. Discussion

The need to allow surgical registrars to acquire operative skills needs to be balanced against the need to ensure that patient outcomes are not compromised. Furthermore, the acquisition of operative skills in trauma surgery has been made increasingly difficult due to a multitude of factors, including reduced work hours, the rise of surgical sub-specialisation, and the increase in non-operative management in trauma [11,12]. Thomson et al., in 2000, demonstrated that almost all (95%) advanced surgical registrars in Australasia expected to be involved in trauma management, only 32% felt their exposure to significant trauma operations during their training was sufficient [13]. Hurst et al., in 2014, surveyed the New Zealand surgical registrars and found that although all registrars felt training in trauma was important, 81% felt their exposure to trauma operations to be inadequate [14]. These findings are similar to those reported in the United Kingdom and Canada [15,16].

This relationship between surgical registrar involvement in operative surgery and clinical outcome was first examined in elective surgery over two decades ago [17]. It has been shown that complex elective procedures may be safely performed by registrars as the primary operator, provided there was a trainer or consultant present during the procedure [17]. In comparison, the situation in acute care and trauma surgery is less clear. The National Emergency Laparotomy Audit (NELA) in the United Kingdom has provided a major impetus towards consultant delivered care in emergency surgery [18]. A recent audit on trauma laparotomy by Marsden et al. suggested that, in the major trauma centres in the United Kingdom, over 90% of cases now received consultant delivered care in the emergency department and operating room [19]. While a shift towards more direct consultant delivered care is likely to have a positive influence on patient outcomes, theoretically, this will inevitably reduce the registrar's experience in obtaining sufficient exposure to achieve competency during their training. Potentially, this could lend itself to a vicious cycle in which newly qualified general surgeons may feel compelled to perform the procedure at the expense of training, even if the case was appropriate for the registrar to perform. In a study by Drake et al. in which ACGME case logs of surgery resident experience in operative trauma was reviewed over a two-decade period, recent general surgery registrars perform far fewer trauma operations than previous registrars and noted that the decline occurred even before the implementation of work-hour restrictions in the United States [20]. This increases the challenge for surgical educators in conducting training for registrars, especially in procedures less frequently performed.

Our current study has shown that the outcomes for trauma laparotomy in our environment are acceptable, provided a surgical registrar undertakes the surgery under appropriate levels of supervision. Patient selection is, however, imperative. In our centre, in the more complex cases, there is a lower threshold to have a consultant trainer present. This is evidenced by the significantly higher rates of consultants in cases with intra-abdominal vascular and hepato-biliary tract injuries. The rate of consultant presence was also higher in liver injuries and gunshot wounds but did not reach statistical significance. Furthermore, the operations performed by consultants were in patients with more deranged physiology than those performed by registrars. This is evidenced by the higher shock index and serum lactate levels, which were all significantly worse in the operations performed by trainers. This is appropriate and suggests that it is possible to identify appropriate patients for the registrar to operate on as the primary surgeon.

Our study was based on retrospective data, limiting the evaluation of training and the rates of supervision. Furthermore, New Zealand's healthcare model differs from other countries that have malpractice claims and thus limits the generalisability of the results. The Accident Compensation Corporation (ACC) in New Zealand covers any iatrogenic events and, therefore, there are no malpractice claims. Medico-legal risks are present, as in any healthcare system. However, the consultant surgeon on-call is responsible for delegating cases appropriately (to the appropriate primary operator) to limit these risks and ensure quality care. Future studies in the form of prospective studies will evaluate training and supervision rates more effectively. Including variables such as time of injury to presentation and the time of presentation to surgery may further inform readers about this topic.

5. Conclusions

Surgical registrars have acceptable outcomes for trauma laparotomy in the appropriate patients. A consultant surgeon should still operate on patients with more significant physiological derangements. Future prospective studies will further inform readers on this topic.

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Institutional Review Board Statement: This study was carried out in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Clinical Audit Support Unit (CASU) of the Waikato District Health Board approved this study (Reference:4142).

Informed Consent Statement: Not applicable—This study was based on previously recorded data and conducted retrospectively with the approval of the Waikato Trauma Department.

Data Availability Statement: Data is available on request.

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Conflicts of Interest: The authors declare no conflict of interest.

References

1. Sidwell, R.A. Intraoperative Teaching and Evaluation in General Surgery. *Surg. Clin. N. Am.* **2021**, *101*, 587–595. [[CrossRef](#)]
2. Marangoni, G.; Morris-Stiff, G.; Deshmukh, S.; Hakeem, A.; Smith, A.M. A modern approach to teaching pancreatic surgery: Stepwise pancreatoduodenectomy for trainees. *J. Gastrointest. Surg.* **2012**, *16*, 1597–1604. [[CrossRef](#)]
3. Schmidt, C.M.; Turrini, O.; Parikh, P.; House, M.G.; Zyromski, N.J.; Thomas, N.A.; Howard, J.; Pitt, H.A.; Lillemoe, K.D. Effect of hospital volume, surgeon experience, and surgeon volume on patient outcomes after pancreaticoduodenectomy: A single-institution experience. *Arch. Surg.* **2010**, *145*, 634–640. [[CrossRef](#)] [[PubMed](#)]

4. Aggarwal, R.; Mytton, O.T.; Derbrew, M.; Hananel, D.; Heydenburg, M.; Issenberg, B.; MacAulay, C.; Mancini, M.E.; Morimoto, T.; Soper, N.; et al. Training and simulation for patient safety. *BMJ Qual. Saf.* **2010**, *19* (Suppl. 2), i34–i43. [[CrossRef](#)] [[PubMed](#)]
5. Van den Berg, I.; Büttner, S.; van den Braak, R.R.J.; Ultee, K.H.J.; Lingsma, H.F.; van Vugt, J.L.A.; Ijzermans, J.N.M. Low Socioeconomic Status Is Associated with Worse Outcomes After Curative Surgery for Colorectal Cancer: Results from a Large, Multicenter Study. *J. Gastrointest. Surg.* **2020**, *24*, 2628–2636. [[CrossRef](#)] [[PubMed](#)]
6. McNeill, D.; Karapetis, C.S.; Price, T.J.; Meagher, P.; Piantadosi, C.; Quinn, S.; Roder, D.; Padbury, R.; Maddern, G.; Townsend, A.; et al. Treatment and outcomes of metastatic colorectal cancer patients in public and private hospitals: Results from the South Australian Metastatic Colorectal Cancer Registry. *Intern. Med. J.* **2020**, *51*, 69–77. [[CrossRef](#)] [[PubMed](#)]
7. Boyd-Carson, H.; Doleman, B.; Lockwood, S.; Williams, J.P.; Tierney, G.M.; Lund, J.N.; National Emergency Laparotomy Audit Collaboration. Trainee-led emergency laparotomy operating. *Br. J. Surg.* **2020**, *107*, 1289–1298. [[CrossRef](#)] [[PubMed](#)]
8. Kasotakis, G.; Lakha, A.; Sarkar, B.; Kunitake, H.; Kissane-Lee, N.; Dechert, T.; McAneny, D.; Burke, P.; Doherty, G. Trainee participation is associated with adverse outcomes in emergency general surgery: An analysis of the National Surgical Quality Improvement Program database. *Ann. Surg.* **2014**, *260*, 483–490, discussion 490–493. [[CrossRef](#)] [[PubMed](#)]
9. de la Mar, A.C.; Lokerman, R.D.; Waalwijk, J.F.; Ochen, Y.; van der Vliet, Q.M.; Hietbrink, F.; Houwert, R.M.; Leenen, L.P.; van Heijl, M. In-house versus on-call trauma surgeon coverage: A systematic review and meta-analysis. *J. Trauma Acute Care Surg.* **2021**, *91*, 435–444. [[CrossRef](#)] [[PubMed](#)]
10. Midland Trauma System. Midland Trauma System Annual Report 2019 [PDF on Internet]. Hamilton (NZ), Midland Trauma System. 2019. Available online: https://www.midlandtrauma.nz/wp-content/uploads/2020/11/MTS-Midland-Trauma-System-annual-report-2019_web.pdf (accessed on 11 August 2020).
11. Strumwasser, A.; Grabo, D.; Inaba, K.; Matsushima, K.; Clark, D.; Benjamin, E.; Lam, L.; Demetriades, D. Is your graduating general surgery resident qualified to take trauma call? A 15-year appraisal of the changes in general surgery education for trauma. *J. Trauma Acute Care Surg.* **2017**, *82*, 470–480. [[CrossRef](#)] [[PubMed](#)]
12. Bittner, J.G.; Hawkins, M.L.; Medeiros, R.S.; Beatty, J.S.; Atteberry, L.R.; Ferdinand, C.H.; Mellinger, J.D. Nonoperative management of solid organ injury diminishes surgical resident operative experience: Is it time for simulation training? *J. Surg. Res.* **2010**, *163*, 179–185. [[CrossRef](#)] [[PubMed](#)]
13. Thomson, B.N.J.; Civil, I.; Danne, P.D.; Deane, S.; McGrath, P.J. Trauma training in Australia and New Zealand: Results of a survey of advanced surgical trainees. *ANZ J. Surg.* **2001**, *71*, 83–88. [[CrossRef](#)] [[PubMed](#)]
14. Hurst, H.; Civil, I.; Hsee, L. Trauma training in New Zealand: A survey of General Surgical trainees. *N. Z. Med. J.* **2015**, *128*, 65–69. [[PubMed](#)]
15. Brooks, A.; Butcher, W.; Walsh, M.; Lambert, A.; Browne, J.; Ryan, J. The experience and training of British general surgeons in trauma surgery for the abdomen, thorax and major vessels. *Ann. R. Coll. Surg. Engl.* **2002**, *84*, 409–413. [[CrossRef](#)] [[PubMed](#)]
16. Engels, P.T.; Versolatto, A.; Shi, Q.; Coates, A.; Rice, T.J. Cause for concern: Resident experience in operative trauma during general surgery residency at a Canadian centre. *Can. Med. Educ. J.* **2020**, *11*, e54–e59. [[CrossRef](#)] [[PubMed](#)]
17. Paisley, A.M.; Madhavan, K.K.; Paterson-Brown, S.; Praseedom, R.K.; Garden, O.J. Role of the surgical trainee in upper gastrointestinal resectional surgery. *Ann. R. Coll. Surg. Engl.* **1999**, *81*, 40–45. [[PubMed](#)]
18. NELA Project Team. *First Organisational Report of the National Emergency Laparotomy Audit*; RCoA: London, UK, 2014.
19. Marsden, M.E.R.; Vulliamy, P.E.D.; Carden, R.; Naumann, D.N.; Davenport, R.A.; National Trauma Research and Innovation Collaborative (NaTRIC). Trauma Laparotomy in the UK: A Prospective National Service Evaluation. *J. Am. Coll. Surg.* **2021**, *233*, 383–394. [[CrossRef](#)] [[PubMed](#)]
20. Drake, F.T.; Aarabi, S.; Garland, B.T.; Huntington, C.R.; McAteer, J.P.; Richards, M.K.; Zern, N.K.; Gow, K.W. Accreditation Council for Graduate Medical Education (ACGME) Surgery Resident Operative Logs: The Last Quarter Century. *Ann. Surg.* **2017**, *265*, 923–929. [[CrossRef](#)] [[PubMed](#)]