Mortality following severe liver trauma is declining at Auckland City Hospital: a 14-year experience, 2006–2020

Nicholas J Fischer

ABSTRACT

INTRODUCTION: Liver injuries sustained in blunt and penetrating abdominal trauma may cause serious patient morbidity and even mortality.

AIM: To review the recent experience of liver trauma at Auckland City Hospital, describing the mechanism of injury, patient management, outcomes and complications.

METHODS: A retrospective cohort study was performed, including all patients admitted to Auckland City Hospital with liver trauma identified from the trauma registry. Patient clinical records and radiology were systematically examined.

RESULTS: Between 2006–2020, 450 patients were admitted with liver trauma, of whom 92 patients (20%) were transferred from other hospitals. Blunt injury mechanisms, most commonly motor-vehicle crashes, predominated (87%). Stabbings were the most common penetrating mechanism. Over half of liver injuries were low risk American Association for the Surgery of Trauma (AAST) grade I and II (56%), whereas 20% were severe grade IV and V. Non-operative management was undertaken in 72% of patients with blunt liver trauma and 92% of patients with penetrating liver trauma underwent surgery. Liver complications occurred in 11% of patients, most commonly bile leaks (7%), followed by delayed haemorrhage (2%). Thirty-two patients died (7%), with co-existing severe traumatic brain injury as the leading cause of death. There was a significant reduction in death from haemorrhage in patients with grade IV and V liver trauma between the first and second half of the study period (p=0.0091).

CONCLUSION: Although the incidence and severity of liver trauma at Auckland City Hospital remained stable, there was a reduction in mortality, particularly death as a result of haemorrhage.

The liver is commonly injured in both blunt and penetrating abdominal trauma.[1,2] Liver trauma can cause life threatening internal haemorrhage and even exsanguination. Delayed liver injury complications are also possible.[3] Auckland City Hospital is a tertiary referral hospital that receives approximately 380 major trauma patients every year from both Auckland and the surrounding regions. Auckland City Hospital has a trauma service and hepatobiliary and liver transplantation units. Throughout the world, as trauma systems and management continue to improve, trauma mortality rates have decreased.

The aim of this study was to review all cases of patients admitted to Auckland City Hospital with liver trauma and to provide a descriptive analysis of the data by evaluating the incidence, mechanism, severity, management, complications and mortality, including any change in outcomes over time.

Methods

The Trauma Services department at Auckland City Hospital collects data on all adults (age 15 and older) admitted to Auckland City Hospital. This database was used to identify all patients admitted with liver trauma. Electronic clinical records

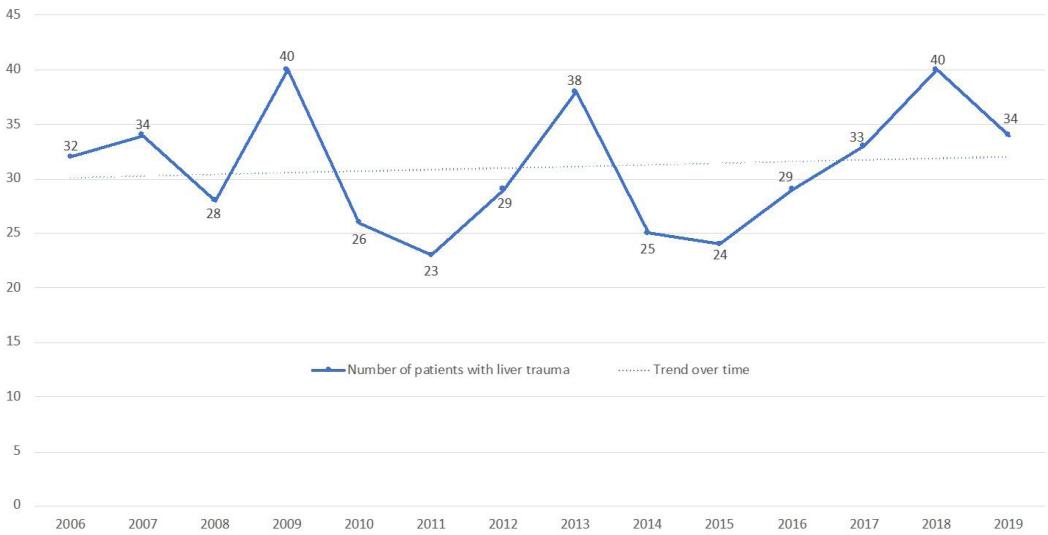
and radiology images were accessible from 2006 onwards. A retrospective review of all patients admitted to Auckland City Hospital with liver trauma between January 2006 and June 2020 was performed. The patients' electronic and scanned hardcopy clinical notes were reviewed, and the mechanism of injury, haemodynamic status, management and complications were recorded. Patients' computed tomography (CT) imaging was reviewed, and the liver injury severity was graded according to the American Association for the Surgery of Trauma (AAST) organ injury scale (2018 revision) for liver trauma.[4] Follow-up using the electronic clinical record was undertaken to examine the patient records for liver-related complications. The number of deaths from haemorrhage in patients with grade IV and V liver trauma was compared between the first (2006–2013) and second (2013–2020) half of the study period, and the number of patients with grade IV and V injuries who underwent laparotomy for shock in the first and second half of the study were also compared. To prevent survivorship bias, these comparisons excluded patients transferred from other hospitals. Fisher exact and Chi Square tests were used for these comparisons, with an alpha significance level of $p=<0.05$. The statistical analysis was performed using SPSS version 27.0 (IBM, Armonk, NY, USA). Data collection and analysis was performed in accordance with local ethical protocols and approval.

Results

Between January 2006 and June 2020, 450 patients were admitted to Auckland City Hospital with liver trauma. The number of patients per year fluctuated between 23 and 40, with a mean of 32 and a stable trend over time (Figure 1). Ninety-two patients were transferred from other hospitals for tertiary trauma services (Figure 2). Blunt injury mechanisms predominated (87%), led by motor vehicle crashes, which accounted for half, followed by falling from a height (Figure 3). Penetrating mechanisms, most commonly stabbings, affected 13% of patients (Figure 4).

In terms of liver trauma severity, milder grades (AAST I and II) accounted for 56%, whereas the most severe grades (AAST IV and V) accounted for 20% (Figure 5). The incidence of severe liver injury was consistent over time. Blunt liver trauma was managed non-operatively for 72% of patients (Figure 6), and 92% of penetrating liver trauma was managed with surgery (Figure 7). Haemodynamic instability requiring laparotomy occurred in 16% of patients with blunt trauma and 10% with penetrating trauma. All four patients with grade V injuries in the first half of the study (2006–2013), and all six patients with grade V injuries in the second half (2013–2020), underwent laparotomy for shock. For grade IV injuries, three out of 19 patients (16%) in the first half, and five out of 27 patients

Figure 1: Annual number of patients with liver trauma admitted to Auckland City Hospital.



NZMJ 13 August 2021, Vol 134 No 1540
ISSN 1175-8716 © NZMA
www.nzma.org.nz/journal

Figure 2: Patient transfers from other district health boards.

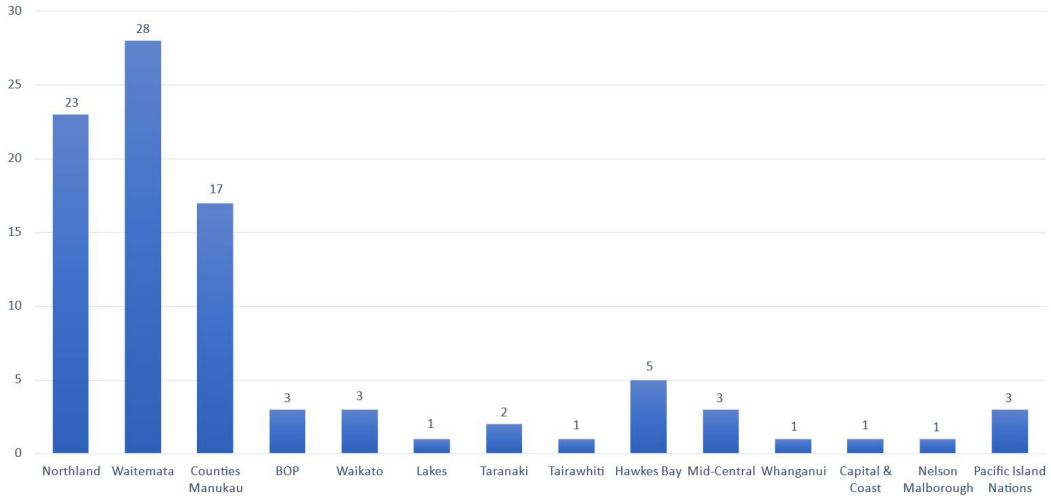
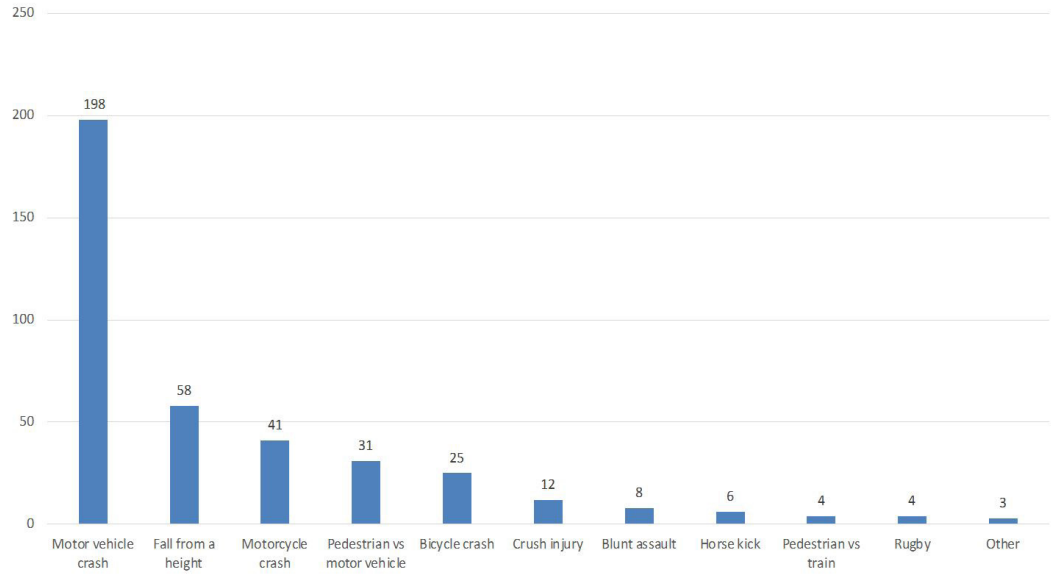


Figure 3: Blunt injury mechanisms.



(19%) in the second half, underwent laparotomy for shock (p=0.810). Interventional radiology procedures were performed on haemodynamically stable liver trauma patients with radiological evidence of active bleeding and those who were initially unstable but responded to fluid resuscitation. Selective hepatic arterial branch angioembolisation was performed on 2% of blunt liver trauma patients within the first 24 hours after injury and a further 2% for delayed haemorrhage (24 hours or more) after injury (Figure 6).

Failed non-operative management occurred in 17 patients with blunt liver trauma (4%), predominantly for the surgical management of bile leakage. Liver complications occurred in 50 patients (11%): 30 patients (7%) with bile leaks and 10 patients (2%) with delayed haemorrhage. Liver necrosis occurred in eight patients and intrahepatic arterial branch pseudoaneurysms in seven patients (Figure 8). As expected, liver complications were more common in high-grade injuries. Additionally, it was found that delayed complications were more common following a blunt (12%) rather than stabbing mechanism (2%).

Thirty-two patients (7%) died, with co-existing severe traumatic brain injury as the leading cause of death. Six patients died from haemorrhage (Figure 9) and all deaths occurred between 90 minutes and 17 hours after injury. Deaths reduced in the second half of the study, with 21 deaths between 2006–2013 and 11 between 2013–2020. This 10-death reduction predominantly came from an absence of deaths from haemorrhage and multiple organ dysfunction syndrome (MODS) in the second half (Figure 10). All four patients with grade V liver trauma in the first half of the study period died from haemorrhage, but all six patients with grade V injuries in the second half survived. There was a significant reduction in death from haemorrhage in patients with severe liver trauma (grades IV and V) from the first and second half of the study, with five deaths out of 20 patients in the first half versus no deaths out of 28 patients in the second (p=0.0091). The median follow-up period using the electronic clinical record was five years. No previously unrecognised liver complication was diagnosed after hospital discharge in any of the 450 patients in this cohort.

Discussion

Solid abdominal organ injuries are feared for their potential for catastrophic haemorrhage and shock, which may lead to a lethal triad of metabolic acidosis, hypo-

Figure 4: penetrating mechanisms.

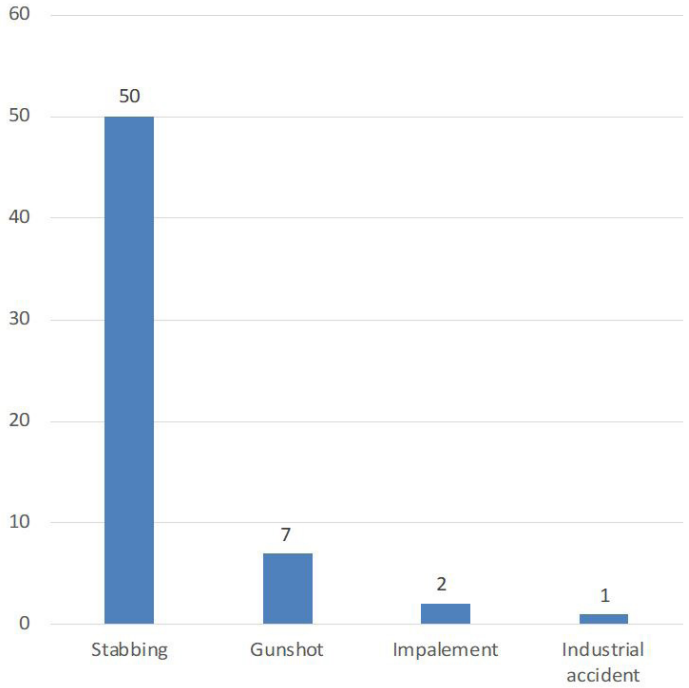


Figure 5: Liver injury severity by AAST grade.

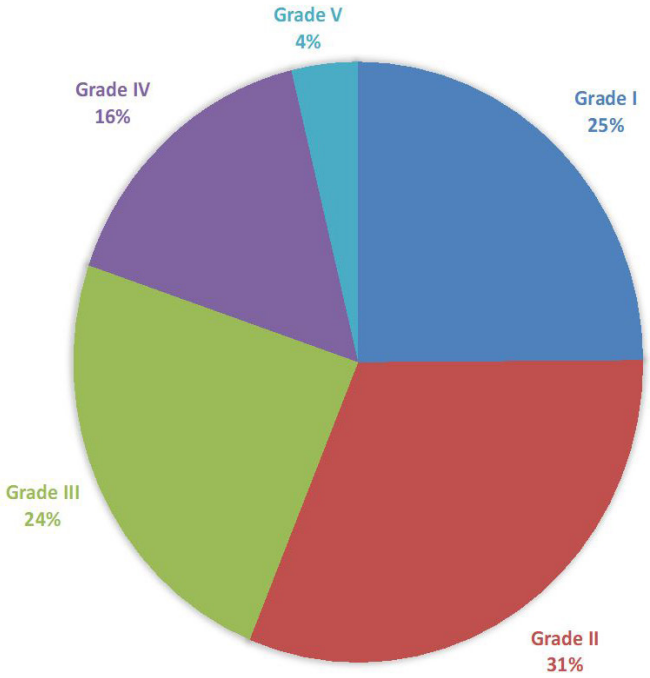
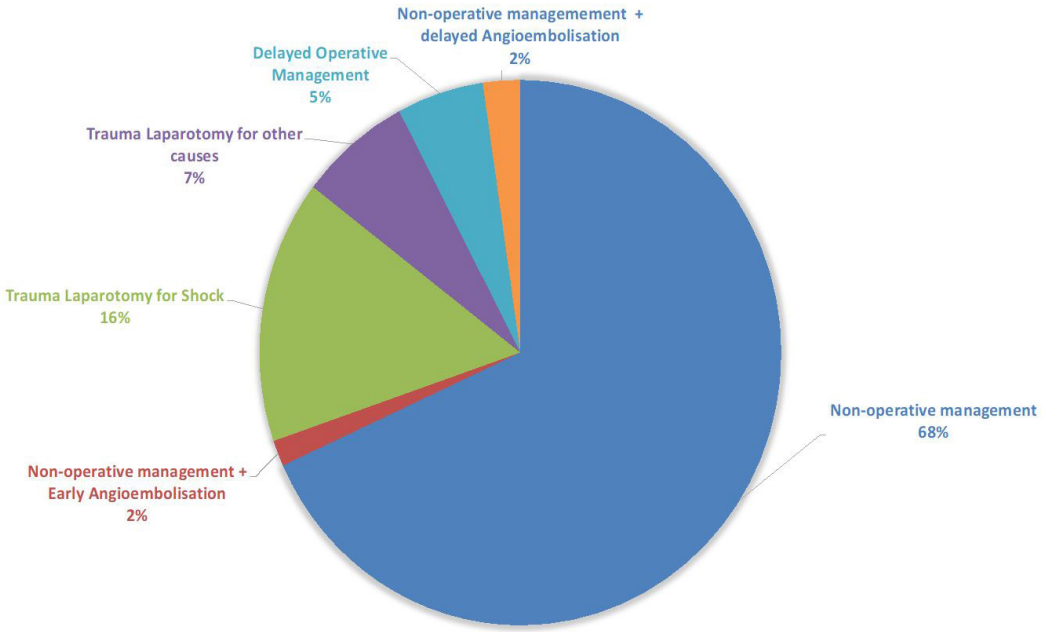


Figure 6: Management of blunt liver trauma.



NZMJ 13 August 2021, Vol 134 No 1540
ISSN 1175-8716
www.nzma.org.nz/journal

Figure 7: Management of penetrating liver trauma.

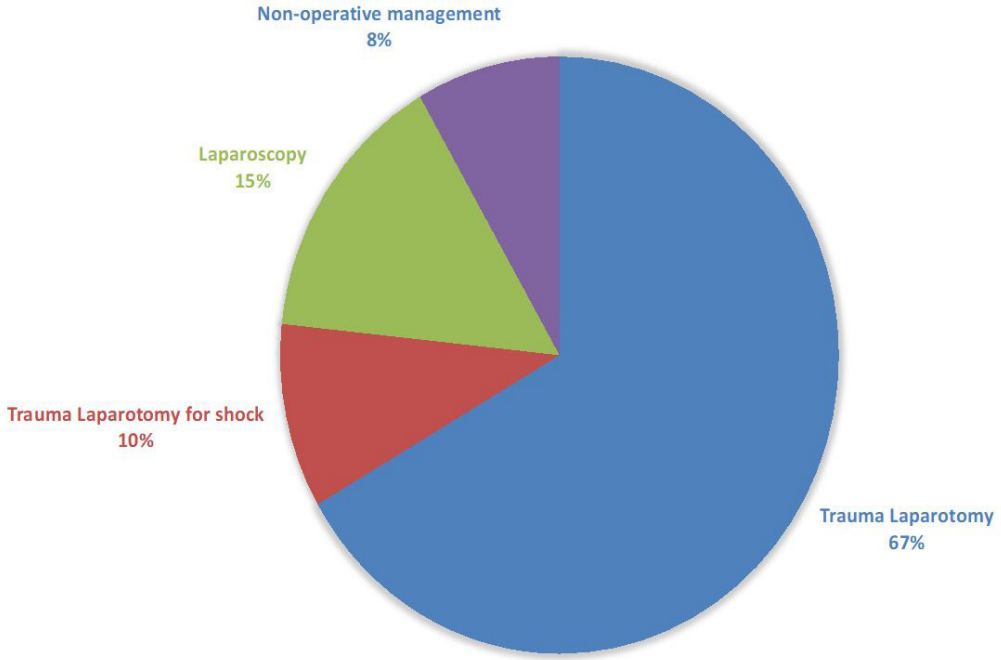


Figure 8: Complications.

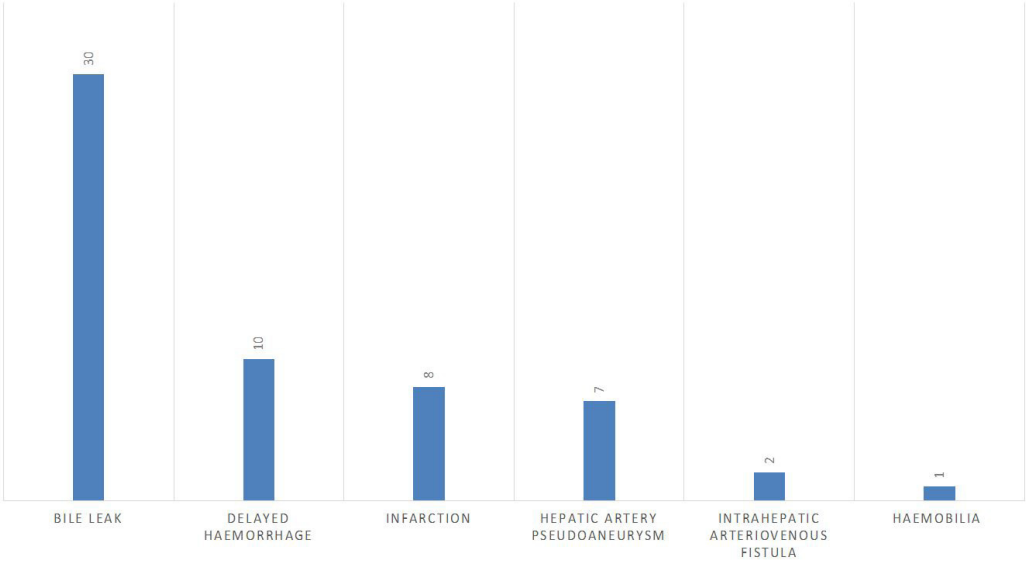


Figure 9: Causes of death in patients with liver trauma.

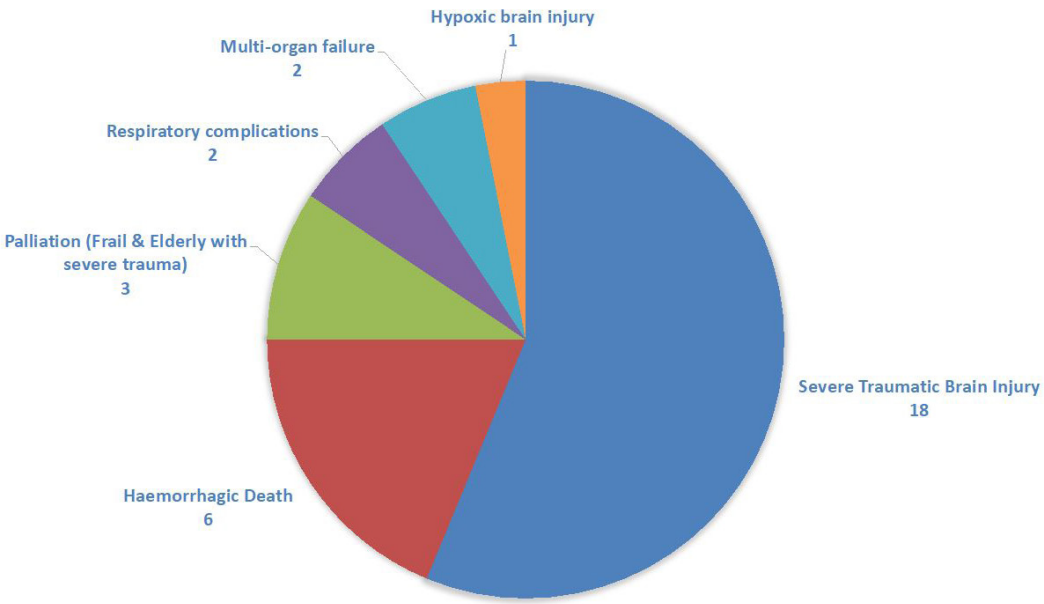
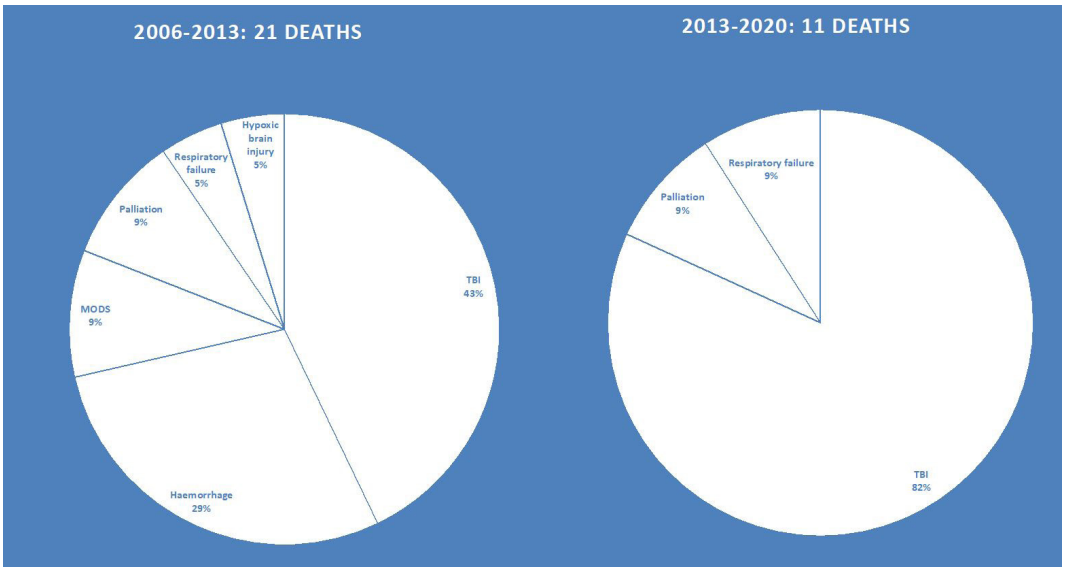


Figure 10: Cause of death: 2006–2013 vs 2013–2020.



NZMJ 13 August 2021, Vol 134 No 1540
ISSN 1175-8716
www.nzma.org.nz/journal

thermia and coagulopathy resulting in an irreversible downward spiral and ultimately exsanguination.[5] However, unlike the spleen, the liver is a vital organ and cannot be completely resected when it is severely injured. Attaining haemostasis in a lacerated liver can prove challenging for the surgeon during laparotomy. Additionally, a severely injured liver may lead to late complications. The Auckland City Hospital experience suggests that, with contemporary trauma management, exsanguination from liver trauma is in fact very rare and appears to be declining. Richardson et al published a landmark paper on the Louisville liver trauma experience of 25 years that included 1,842 patients.[6] They demonstrated that increasing non-operative management of liver trauma reduces associated mortality over time, postulating that operative intervention can actually worsen bleeding and, subsequently, complications from liver trauma. Since then, non-operative management of liver trauma has evolved to become the standard of care for haemodynamically stable patients.[7] The Auckland City Hospital experience demonstrates a clear preference for non-operative management of blunt liver trauma, with patients only undergoing surgery in cases of haemodynamic instability despite fluid resuscitation, or for other indications for laparotomy (eg, hollow visceral injury or delayed complications).

Our overall mortality rate of 7% was similar to other recent Australasian series.[8] However, during the second half of our study period, there was a trend towards a further decrease in the mortality rate to 5%, predominantly due to an absence of death from haemorrhage and MODS, and almost all deaths during the second half were due to co-existing severe traumatic brain injury. Interestingly, there was no change in the non-operative management rate for patients with high-grade liver injuries between the 2006–2013 and 2013–2020 periods, suggesting it is unlikely that changes in surgical management can explain this reduction in haemorrhagic death. Furthermore, our data also suggest that interventional radiology procedures were unlikely to have had a significant impact on this reduction in haemorrhagic death, since early angioembolisation was only performed in a small subset of patients (2%) with active arterial bleeding seen on their CTs and who were haemodynamically stable enough to be taken to the angio-suite.

Therefore, the explanation for this reduction in haemorrhagic death is likely multifactorial and a result of improvements in multidisciplinary trauma management and critical care. Evidence emerging in trauma literature suggests that changes in fluid resuscitation practice, and in particular utilising haemostatic resuscitation principles with early administration of blood products (eg, coagulation factors, avoidance of crystalloid fluids and increasing use of tranexamic acid), may help prevent coagulopathy and fatal haemorrhage.[9] Further research into specific factors responsible for this reduction in fatal haemorrhage seems warranted.

Overall, the liver-specific complication rate of 11% predominantly occurred in high-grade and blunt liver trauma. This led to a failure of non-operative management in 4% of patients with blunt liver trauma, mostly due to bile leak. Interestingly, though, there was not one patient that developed a new liver complication after discharge from hospital, as all liver complications were diagnosed during index admission.

Limitations of the applicability of these findings to other centres include its single centre nature in a New Zealand hospital and its retrospective data collection, and thus the risk of inherent bias in such methodology. Furthermore, Auckland City Hospital is a tertiary referral centre and receives a disproportionately high grade of severity of liver trauma specifically for trauma and liver surgical expertise.

Conclusions

The incidence and severity of liver trauma at Auckland City Hospital has remained stable over time. However, with improvements in multidisciplinary trauma management, there has been a reduction in mortality from haemorrhage. Further research into changes in management during this time may elucidate specific beneficial practice changes.

Competing interests:
Nil.
Acknowledgements:
Thank-you to everyone in the Trauma Service at Auckland Hospital, in particular Prof Ian Civil and Mr Li Hsee. Thanks also to Associate Professor Adam Bartlett and Professor John McCall.
Author information:
Nicholas J Fischer: MBChB FRACS, Liver Transplantation Fellow, New Zealand Liver Transplant Unit, Auckland City Hospital.
Corresponding author:
Nicholas J Fischer: MBChB FRACS, Liver Transplantation Fellow, New Zealand Liver Transplant Unit, Auckland City Hospital
NFischer@adhb.govt.nz
URL:
www.nzma.org.nz/journal-articles/mortality-in-severe-liver-trauma-is-declining-at-auckland-city-hospital-a-14-year-experience-2006-2020

REFERENCES

1. Matthes G, Stengel D, Seifert J. et al. Blunt Liver Injuries in Polytrauma: Results from a Cohort Study with the Regular Use of Whole-body Helical Computed Tomography. World J. Surg. 27, 1124–1130 (2003). https://doi.org/10.1007/s00268-003-6981-0
2. Tarchouli M, Elabsi M, Njoumi N, Essarghini M, Echarrab M, Chkoff MR. Liver trauma: What current management? Hepato-biliary Pancreat Dis Int. 2018 Feb;17(1):39-44. doi: 10.1016/j.hbpd.2018.01.013. Epub 2018 Jan 31. PMID: 29428102.
3. Hommes M, Navsaria PH, Schipper IB, Krige JE, Kahn D, Nicol AJ. Management of blunt liver trauma in 134 severely injured patients. Injury. 2015 May;46(5):837-42. doi: 10.1016/j.injury.2014.11.019. Epub 2014 Nov 26. PMID: 25496854.
4. Kozar RA, Crandall M, Shanmuganathan K, et al. Organ injury scaling 2018 update: Spleen, liver, and kidney [published correction appears in J Trauma Acute Care Surg. 2019 Aug;87(2):512]. J Trauma Acute Care Surg. 2018;85(6):1119-1122. doi:10.1097/TA.0000000000002058
5. Feliciano D, Mattox K, Moore E. Trauma, 9th edition. New York: McGraw Hill. 2021.
6. David Richardson J, Franklin GA, Lukan JK, Carrillo EH, Spain DA, Miller FB, Wilson MA, Polk HC Jr, Flint LM. Evolution in the management of hepatic trauma: a 25-year perspective. Ann Surg. 2000 Sep;232(3):324-30. doi: 10.1097/00000658-200009000-00004. PMID: 10973382; PMCID: PMC1421146.
7. Brooks A, Reilly J, Hope C, Navarro A, Naess P, Gaarder C. Evolution of non-operative management of liver trauma. Trauma Surg Acute Care Open. 2020:5:e000551
8. Suen K, Skandarajah AR, Knowles B, Judson R, Thomson BN. Changes in the management of liver trauma leading to reduced mortality: 15-year experience in a major trauma centre. ANZ J Surg. 2016 Nov;86(11):894-899. doi: 10.1111/ans.13248. Epub 2015 Aug 2. PMID: 26235220.
9. Cole E, Weaver A, Gall L, West A, Nevin D, Tallach R, O'Neill B, Lahiri S, Allard S, Tai N, Davenport R, Green L, Brohi K. A Decade of Damage Control Resuscitation: New Transfusion Practice, New Survivors, New Directions. Ann Surg. 2019 Oct 22. doi: 10.1097/SLA.0000000000003657. Epub ahead of print. PMID: 31651535.