Te Tāhū Hauora
Health Quality & Safety Commission

A thematic analysis of sepsis-related adverse events reported to Te Tāhū Hauora between 2017 and 2022

June 2024

Contents

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Te Kāwanatanga o Aotearoa
New Zealand Government

Purpose

This report is a thematic analysis of the findings and recommendations from sepsis-related adverse events reported to Te Tāhū Hauora Health Quality & Safety Commission (Te Tāhū Hauora) over the 5 years from 2017 to 2022. It forms part of wider sepsis scoping work being undertaken to inform a national quality improvement programme that aims to improve outcomes for people experiencing sepsis in Aotearoa New Zealand.

Introduction

Sepsis is a leading cause of death worldwide and a serious cause of harm to thousands of New Zealanders each year.[1,2] Sepsis is defined as being a 'life-threatening organ dysfunction due to a dysregulated host response to infection'[3] and is associated with high morbidity, high treatment costs and long-term disability.[4] Research done in Aotearoa New Zealand has indicated that 75–80 percent of people with sepsis present to hospital via the emergency department[5] and 17 percent will require admission to the intensive care unit.[6]

Best practice guidelines recommend the use of standardised risk stratification tools that alert clinicians to initiate prompt resuscitation and treatment. The 'sepsis six' is a bundle of six actions that have been shown to improve outcomes when delivered within the first hour of sepsis being recognised.[7]

An adverse event can be defined as an event in which a person receiving health care experienced harm. The harm experienced is not related to the natural course of the illness or treatment and differs from the immediate expected outcome of care. Harm can be physical, psychological, cultural or spiritual.[8] Adverse events that occur in health care settings are reported and reviewed to learn what led to the harm occurring and to put systems in place to minimise the risk of it re-occurring. Adverse events are given a severity assessment code (SAC) of between 1 and 4 based on the severity of the outcome. SAC 1 and SAC 2 events are those that result in death or severe loss of function. These must be reported* to Te Tāhū Hauora within 30 working days (part A). The health provider then carries out a review, and the findings and recommendations of that review should then be reported to Te Tāhū Hauora within 120 working days (part B).

In 2023, Te Tāhū Hauora published an updated national adverse events policy that shifts the focus to 'system safety'.[9] The adverse event reviews included in this analysis occurred before this new policy was published and used older review methodologies.

Methodology

This report covers 151 sepsis-related adverse events that were reported to Te Tāhū Hauora between 2017 and 2022. The adverse events database was searched using a series of terms to identify reports that contained key words within the database event descriptors. The search terms were:

* Before 1 July 2023, the timeframes for reporting adverse events to Te Tāhū Hauora were 15 working days for part A and 70 working days for part B.

- sepsis/septic
- septicaemia
- bacteraemia/bacteremia
- infection
- antibiotics
- healthcare-associated infection/HAI.

Events related to infection or bacteraemia were reviewed to determine whether there was evidence of clinical deterioration related to organ dysfunction before they were included in the analysis.

Part B reports and/or de-identified full reports were available for 92 adverse events. Reports were identified using an internal reference code. Part B reports do not contain any information that can be used to identify individual patients or staff. The reports outline the findings and recommendations from health providers' adverse event reports. This thematic analysis aims to highlight key themes within those findings and recommendations. The information in some of the Part B reports is limited, for example, only included recommendations and no findings.

We excluded 15 adverse events from the analysis because:

- the event happened earlier than 2017 (two reports)
- the event was downgraded to a SAC 3 event (five reports)
- there was no evidence of sepsis (one report)
- the patient had confirmed or suspected sepsis but the adverse event related to something other than sepsis, such as developing a pressure injury (seven reports).

In total, 77 adverse events were included in the analysis. The findings of these reports were themed as relating to the parts of the system outlined in the systems engineering initiative for patient safety (SEIPS) model.[10] These are: person factors, technology and tools, task factors, work environment, organisation factors and external influences. Most of the factors identified by the authors of the adverse event reports were person factors. This is probably because older methods of reviewing adverse events focused on cause and effect and put a greater emphasis on the actions of individuals without always understanding the system factors that informed the decisions made on the day.

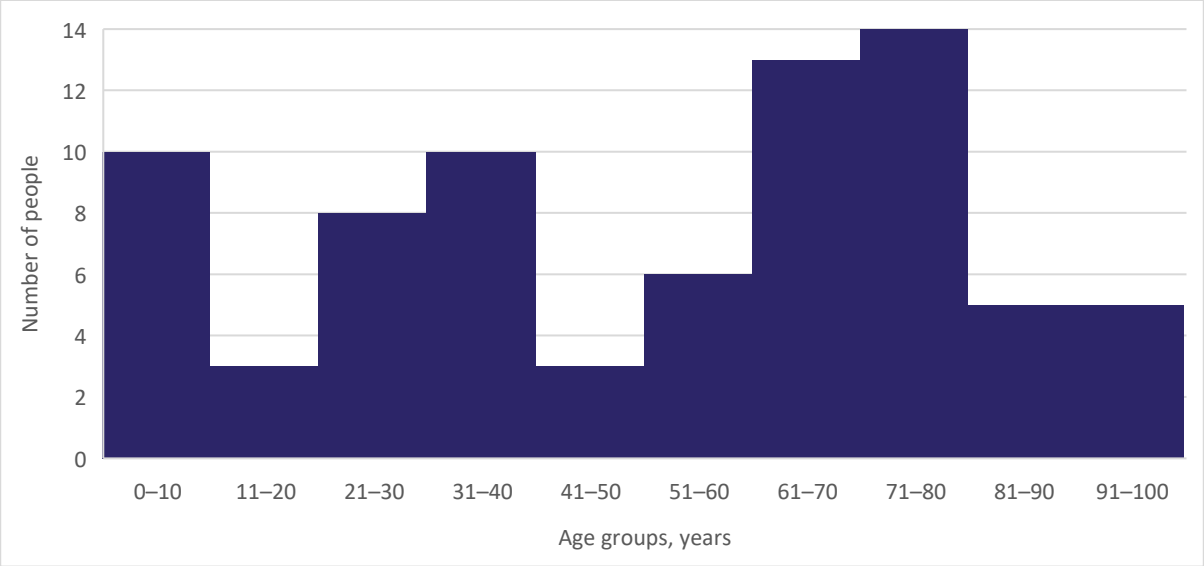
Recommendations made by the authors of the reports were themed by the recommended action and then coded by the focus of this action.

Demographics

Age

The age of people included in the analysis ranged from newborn to 92 years. The median age of people included in the analysis was 59 years. Figure 1 shows the distribution of age groups.

Figure 1: Age groups of people included in this thematic analysis

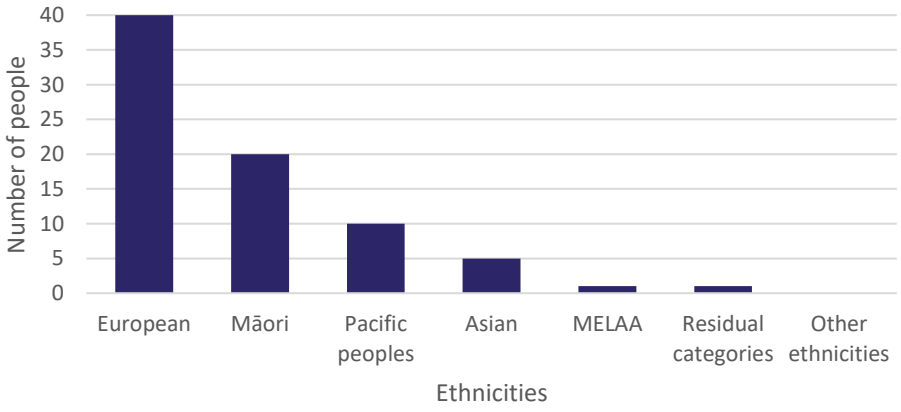


Source: Te Tāhū Hauora adverse events database.

Reported ethnicity

The Manatū Hauora Ministry of Health level 1 ethnicity categories of the people included in the analysis are shown in Figure 2. Māori make up 26 percent of the people included in the analysis; 13 percent are Pacific peoples. This is higher than the percentages of Māori and Pacific peoples in the general population. Māori and Pacific peoples in Aotearoa have higher rates of infection-related hospital admissions than non-Māori, non-Pacific people.[11] The over-representation of Māori in these adverse event reports aligns with the findings of research undertaken in Aotearoa that found that sepsis is over three times more likely in people of Māori ethnicity and that this corresponded to an increased risk of in-hospital death with sepsis.[12,13,14]

Figure 2: Reported Manatū Hauora level 1 ethnicities of people included in the analysis



Source: Te Tāhū Hauora adverse events database. MELAA = Middle Eastern/Latin American/African.

Gender

Of the people included in the analysis overall, 41 (53 percent) were female and 36 were male (47 percent).

Outcome

Of the people included in the analysis overall, 40 (52 percent) died. This is higher than the overall in-hospital sepsis mortality rate in Aotearoa New Zealand.[15] This analysis only looks at adverse events classified as SAC 1 or 2, which means the event resulted in death or significant loss of function. Therefore, people included in the analysis are more likely to have died than those in the overall sepsis population.

Sepsis cohorts

Adults

Of the 77 adverse events included in the analysis, 54 involved non-pregnant adults. The youngest person in the adult cohort was 18 years, and the oldest person was 92 years.

Neonatal and paediatric

Seven of the adverse events were in neonates, and three were in children aged less than 5 years.

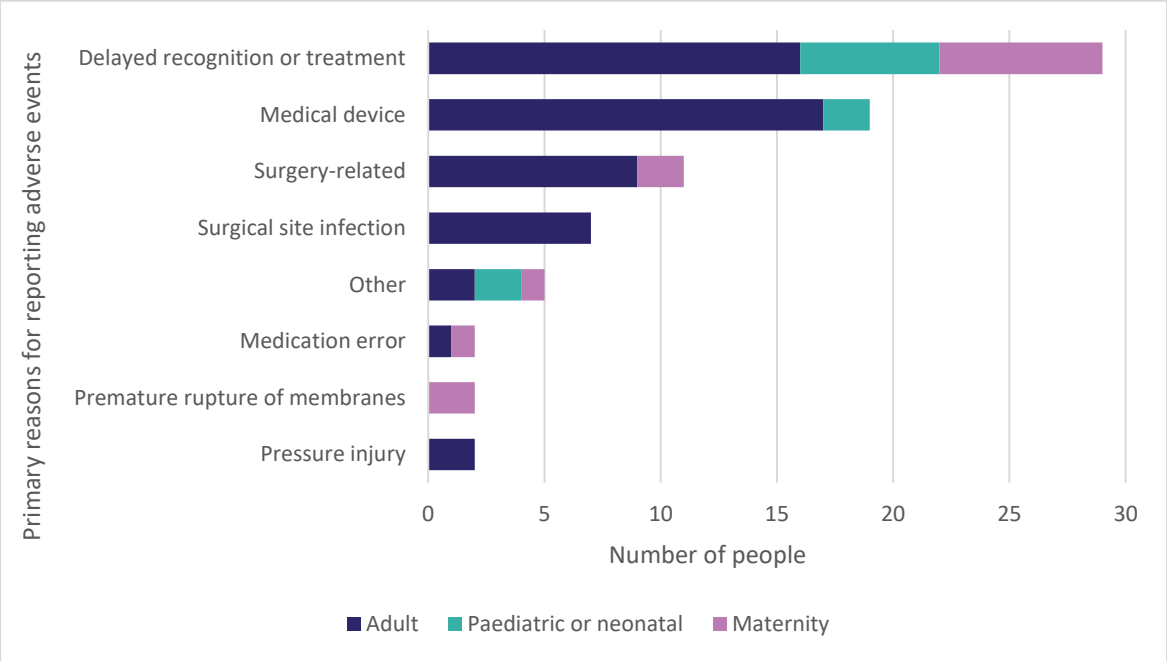
Maternity

In total, 13 adverse events involved pregnant or recently pregnant people. The youngest person in the maternity cohort was aged 19 years; the oldest was aged 40 years.

Primary reasons for adverse events being reported

Adverse events were given a category based on the primary reason for the adverse event being reported, as identified by the submitted report. The most common category was delayed recognition or treatment, and these accounted for 38 percent of adverse events. The top four categories together accounted for 86 percent of adverse events. Figure 3 shows the primary reasons for reporting adverse events, by category and patient group.

Figure 3: The primary reasons for reporting adverse events, by category and patient group



Source: Te Tāhū Hauora adverse events database.

Summary of findings

Adverse event reports contain key findings that the review team believe have contributed to the event. The findings of the 77 reports included in the analysis are summarised below, grouped by the primary reasons the adverse events were reported.

Delay in recognition or treatment of sepsis

In 29 reports, the primary reason was a delay in recognition or treatment of sepsis. A relatively high proportion of these were in the maternity and paediatric/neonatal cohorts. The ethnicity breakdown in these groups was similar to that in the group as a whole.

Thirteen people who experienced delays in recognition or treatment of sepsis developed sepsis at home and presented to hospital via an emergency department. Of these, four people had presented to a doctor or midwife with symptoms such as fever or tachycardia in the hours or days before, including one person who presented to urgent care.

Seven people who experienced delays in recognition or treatment of sepsis were hospital inpatients when they developed sepsis. For the remaining nine people, the reports did not contain enough information to determine where sepsis developed.

There were no clear themes in the causative organism that led to sepsis for people in this category. For two of the infections reported in this category, a medical device (portacath) was the infection source. However, they were included in this category because a delay in recognition or treatment was felt to be the primary reason for the adverse event.

Person factors

Many reports described factors that made people more susceptible to developing severe infections and sepsis. These included being colonised with high-risk organisms and being neutropenic. Several people were described as having atypical presentations or subtle signs of sepsis such as not having a fever. It is known that people with sepsis will sometimes present with a low temperature rather than a fever and may have non-specific and non-localised presentations.[16,17] The adverse event reports did not contain enough information to indicate whether a sepsis screening tool, if used, would have detected that these people had sepsis or were vulnerable to deterioration.

Many reports described actions by staff that led to delays in recognising or treating sepsis. These included interpreting blood results incorrectly and missing opportunities to order tests that would have indicated sepsis. Best practice guidelines from Aotearoa New Zealand and overseas state that people with red flags for sepsis should receive antibiotics within 1 hour following recognition of sepsis.[18,19] Despite this, delays in the prescribing and administration of antibiotics in people showing signs of sepsis and/or physiological instability were commonly described.

Problems with documentation, including the recording of vital signs, fluid balance and clinical notes, were commonly reported. Accurate vital sign recordings and early warning scores can indicate that a person is more likely to deteriorate and prompt staff to follow an escalation pathway.[20]

Several reports described that the person or their whānau raised concerns to health care staff but felt the concerns went unheard. Concerns raised by people and their families or whānau can alert staff to more subtle signs of deterioration, such as changes from usual behaviour.[21]

Communication problems between clinicians and care not being escalated to senior staff were commonly described factors. Communication problems included difficulties or delays in coordinating care between clinical areas, which sometimes led to people remaining in the emergency department or ward when they required intensive care support.

Technology and tools

One report discussed that the software used to input and view vital signs led to the doctor not being able to see up-to-date vital signs on the electronic system. This meant that health care workers were not aware of the person's clinical status. Two reports described situations where blood tests were requested by a referring health provider but not followed up or actioned by the receiving hospital, which led to delays in recognising sepsis. The reports did not state how visible or accessible these results were to the receiving hospital, for example, whether they could be accessed through the same electronic system. Other findings related to technology and tools included the unavailability of resuscitation equipment for bariatric patients and delays receiving laboratory results because the required equipment was not available.

Task factors

The management of a person with sepsis is a complex task, and sepsis can be difficult to diagnose. Additional challenges are presented when staff are working in pressured clinical

environments.[22] Few reports discussed this complexity in their findings. One report discussed difficulties in obtaining blood samples in a person with difficult intravenous (IV) access. One report discussed that the prescribing of an incorrect antibiotic dose related to multiple and conflicting guidelines within the hospital.

Work environment

No reports mentioned work environment.

Organisation factors

Several organisation factors were described as contributing to the delays in recognition or treatment of sepsis. These included emergency departments being busy, which led to delays in people being assessed. Several reports described either a shortage of staff or a junior skill mix as contributing to the event. High medical workloads were discussed as contributing to delays in assessment and treatment. Only one report described a lack of staff training about sepsis as a factor that may have led to delayed recognition and treatment.

Several reports discussed that care was not escalated in a timely way or that the early warning system escalation pathway was not followed. One report linked this to a lack of organisational oversight of the early warning system. Some reports identified that they were not using early warning systems in the area where the adverse event happened (such as in urgent care or during active labour) and that this contributed to a lack of established processes for escalating care. There is some evidence about the use of early warning systems in pre-hospital settings,[23] but they have not been validated in all populations.[24]

Other reports that described delays happening before admission found that escalation and referral to senior staff was timely and appropriate once the person was admitted to hospital.

Seven reports related to delays in recognition or treatment discussed the use of sepsis pathways (Table 1).

Table 1: Summary of findings relating to sepsis pathways

Finding	Number
Lack of sepsis pathway	3
Sepsis pathway existed but was not followed	1
Single specialty sepsis pathway that does not link to other specialty sepsis pathways within the organisation	1
Name of pathway did not match presentation of patient	1
Sepsis pathway was in place and followed	1

Source: Te Tāhū Hauora adverse events database.

Of note, one report stated that the pathway was called ‘the febrile neutropenia pathway’ but the patient did not present with a fever. The report discussed how this naming led to an emphasis on the symptom ‘fever’ as a prompt for staff to follow this pathway. The UK National Institute for Health and Care Excellence uses the terminology ‘neutropenic sepsis’, which may be preferable.[25]

One report noted that the patient initially presented to a general practitioner but that they did not stock antibiotics to be used in time-critical situations.

External influences

One report discussed external influences as a factor in the adverse event, specifically that a greater number of staff were new to their roles because of the response to the COVID-19 pandemic.

Medical device- and surgery-related infections leading to sepsis

The next three most common categories of adverse events were medical device-related, surgery-related and surgical site infections. They have been analysed as a group because the findings overlap. Together, these three categories make up 48 percent of the events included in the analysis.

Nineteen adverse events were primarily due to infection from a medical device, most commonly peripheral IV lines (12 events), with central lines and a ventricular reservoir making up the remainder. Eleven adverse events were related to surgery, and these included retained items, aspiration pneumonitis and sepsis events related to the surgical technique. Seven adverse events related to people presenting with surgical site infections.

The median age of people with a healthcare-associated infection that led to sepsis was 71 years, which is significantly higher than in the overall group. People in this group were slightly more likely to be of European or other ethnicity than those in the overall group. Mortality in this group was 53 percent, similar to in the overall group. *Staphylococcus aureus* was the most commonly identified organism.

Person factors

Most people in the medical device and surgical site infection categories became unwell with sepsis at home. These people either had been recently discharged from hospital or were living at home with medical devices. Many had significant comorbidities, and all had risk factors for developing sepsis. Several people who developed sepsis from peripheral IV catheter infections had symptoms of thrombophlebitis at the time of discharge from hospital. One person presented to the emergency department with a surgical site infection, but signs of sepsis were not recognised, and the person re-presented the following day in septic shock. The nature of reported events means that a greater number of people in the surgery-related category were hospital inpatients when they developed sepsis.

The reports contained little evidence that people were aware of the risks of sepsis or what symptoms should have prompted a return to hospital. The exception to this is one person who had experienced sepsis previously. This person presented early to the emergency department and was treated promptly.

Technology and tools

Interestingly, although many of the reports in this category were related to medical devices, few findings related to technology and tools, and no key themes were identified. One report, where sepsis was related to a retained item, noted that surgical dressings without embedded radiolucent strips were being used, which may have made it more difficult to detect a retained foreign body. One report where a person developed sepsis from a peripheral IV line infection discussed that an alternative form of vascular access may have been more appropriate.

Task factors

Several reports where sepsis was related to an infected peripheral IV line mentioned factors related to IV line insertion and incomplete documentation related to assessment and maintenance of IV lines. Incomplete documentation of the insertion and removal of IV lines led to difficulties in monitoring dwell time or knowing where lines had previously been inserted. Reviews found that, when a person began to deteriorate, the peripheral IV line was not always recognised as a possible source of infection.

Many reports described aspects of care considered to be good practice for the management of sepsis. For example, that blood cultures and/or septic screens were done promptly when the person became febrile. Antibiotics are described as having been prescribed appropriately.

Work environment

No reports described factors relating to the work environment.

Organisational factors

Fewer organisational factors were described in this group of reports. Some reports had similar findings to those described in the ‘delay in recognition or treatment of sepsis’ group. These included high workloads, multiple handovers between staff and failure to escalate to senior staff when vital signs were abnormal.

One report mentioned that there was no process to follow when someone was sent on overnight leave from hospital with a peripheral IV line in place. It also discussed that training in how to insert peripheral IV lines, and requirements to demonstrate competency, vary between different health professions.

One report highlighted that poor hand hygiene compliance may have contributed to a person developing a peripheral IV line infection. Several reports mentioned that there were no standardised processes recommending actions where a peripheral IV site appeared inflamed (ie, no guideline on antibiotic management of line-associated thrombophlebitis; no clear information given to the patient when they were discharged from hospital).

Reports in two surgery-related events discussed insufficient documentation of preoperative planning, and communication breakdowns between medical staff. Two reports where sepsis was related to retained items discussed a lack of formalised process to reconcile equipment at the end of procedures undertaken outside operating rooms.

No reports in this group discussed pre-hospital factors. Where care was transferred between a referring hospital and a tertiary centre, escalation and treatment was considered to have been appropriate.

External influences

One report mentioned external influences as a factor. This related to the pressure of the COVID-19 pandemic, which contributed to a person’s early discharge.

Other primary reason categories

Eleven other adverse events did not fit into the categories described above. Together, these account for 14 percent of the events included in the analysis. These included two people with sepsis relating to a pressure injury; two medication errors that contributed to people developing pancytopenia, leading to sepsis; and two sepsis events relating to premature rupture of membranes in pregnancy.

Person factors

As with the adverse events described earlier, many of the people who developed sepsis had comorbidities and risk factors. The reports also described active errors by staff because they were working in unfamiliar areas and complex clinical situations.

Technology and tools

The two medication errors that contributed to sepsis both related to the administration of methotrexate to people with end-stage renal failure. Methotrexate is usually contraindicated in people with impaired renal function, and methotrexate toxicity has been associated with pancytopenia and sepsis.[26]

Task factors

Poor documentation was again a theme of the findings in these adverse event reports. They included pressure injury assessments and documentation of whether antenatal bloods had been taken. One report mentioned that documentation was a mixture of paper and electronic, which made it more difficult to find information.

Work environment

There were no findings about the work environment.

Organisation

Three reports discussed problems with communication and escalation to senior or specialist staff. Two reports discussed staffing levels and unit busyness.

Summary of recommendations

Adverse event reports also contain recommendations. These recommendations were developed locally by the review team in each health organisation for local implementation. The 77 adverse event reports in this analysis contained 255 separate recommendations. Systems-focused interventions, such as forcing functions, standardisation and automation, are recognised as being more effective than person-focused interventions, such as policies, education or training and alerts.[27] Many of the recommendations in the reports were person-focused and often concentrated on one service or organisation rather than looking across the entire patient journey. This is likely because of the nature of adverse event reviews, where attention is focused on the clinical area where the event occurred.

Recommendations specific to sepsis, related to patient deterioration and that focus on communication and teamwork are discussed below. The full list of local recommendations contained within the adverse event reports is summarised in Appendix 1.

Sepsis-specific

In total, 11 recommendations were to implement or improve a sepsis screening tool or pathway. Several of these reports recommended implementing pathways within a particular service, such as the emergency department. One report recommended a 'whole of institution' sepsis programme, and one recommended aligning sepsis pathways across the local health system. Five reports recommended providing education or training about the recognition and management of sepsis. There were no consumer-focused recommendations specifically related to sepsis, such as increasing patient or public awareness of the risk factors for or signs of sepsis.

Communication, escalation and teamwork

There were 37 recommendations to strengthen communication, escalation processes and teamwork. Some of these recommendations were quite high level without measurable steps for how they would be achieved. Key themes within these recommendations related to strengthening processes for escalation from junior to senior doctors and noted that communication about unstable patients should take place at a 'senior doctor to senior doctor' level. There were three recommendations for formalised multidisciplinary team assessment and stabilisation of critically unwell patients.

A common theme among the reviews was that the processes for notification of positive blood cultures and for escalation once a positive blood culture result had been received should be reviewed.

Early warning systems and the Kōrero Mai programme

During the time period that these reports span (2017–2022), nationally standardised early warning systems were being tested and implemented for hospital inpatients across the adult, maternity, paediatric and neonatal populations. The reports included 27 recommendations about implementing or reviewing current early warning systems to recognise and respond to acute deterioration and providing education to support this.

There were four recommendations to either implement or review the implementation of Kōrero Mai, a national programme to strengthen the processes for patients, family and whānau to escalate concerns about deterioration.[28] The national paediatric early warning system includes a requirement for nurses to assess whānau concern alongside other vital signs.[29] These programmes have now been widely implemented across hospitals in Aotearoa New Zealand, and work is ongoing to ensure they are sustained.

Discussion

This report summarises the key themes among the findings and recommendations from 77 sepsis-related serious adverse events that occurred in Aotearoa New Zealand over a 5-year period. Adverse event reports can provide valuable qualitative information about the

potential contributing factors to an adverse event. Although adverse event reports generally focus on the department or organisation where the event happened, this thematic analysis is an opportunity to look at sepsis-related events across the health system.

Māori are over-represented in sepsis hospital admissions[30] and are therefore over-represented in the adverse event reports included in this analysis. The principles of Te Tiriti o Waitangi oblige health care organisations in Aotearoa New Zealand to achieve equitable health outcomes for Māori. A sepsis improvement programme must be equity focused to improve outcomes across the population.

This report has some limitations. Not every serious adverse event had an associated part B report, and differing reporting requirements over time meant that some part B reports contained more detail than others. This means that the findings and recommendations of some sepsis-related adverse event reviews were not reported to Te Tāhū Hauora and therefore could not be included in this analysis. In 2023, the requirements changed to request that full de-identified reports be submitted, which will make future thematic analyses easier.

Adverse event reports alone do not give the full picture of sepsis-related harm. Wider sepsis scoping work by Te Tāhū Hauora has examined the number of sepsis-related complaints sent to the Health and Disability Commissioner and findings from the national mortality review committee's work on sepsis. This information has been used, alongside data from the national minimum data set and the Accident Compensation Corporation (ACC), to better understand sepsis-related harm.

This report draws on the findings and recommendations identified by the authors of the adverse event reports. The reviews largely used older methods, which commonly emphasised the actions of individuals, so recommendations focused on person-centred activities such as reminders, policies and education. There is a recognised need for adverse event reviews to move from this person-centred focus to a systems safety approach.[31]

Sepsis events that occurred in aged residential care facilities are largely missing from this analysis. The revised Ngā Paerewa standards[32] require these facilities to now report adverse events to Te Tāhū Hauora in the same way that hospitals are required to. This requirement may see an increased number of sepsis adverse events reported, as sepsis is a common contributing factor in complaints about aged care facilities sent to the Health and Disability Commissioner.[33]

Delays in the recognition or treatment of sepsis are the most common reason for adverse events to be reported. Although many health organisations have begun work to improve this, a sepsis improvement programme that extends across the health system will provide an opportunity for a coordinated and standardised approach to the recognition and treatment of sepsis.

Opportunities exist to strengthen systems to improve the recognition and immediate treatment of sepsis in pre-hospital settings, such as general practice, urgent care and ambulance, as well as in hospital. Improved sepsis screening and resuscitation in pre-hospital settings may reduce delays to treatment and improve outcomes.

Sepsis events resulting from medical devices, such as peripheral IV lines, or from surgical site infections were another common reason for adverse events to be reported. These sepsis events often happen once a person has been discharged from hospital and returned

home. The adverse event reports contained very few consumer-focused recommendations, but this is an important area for improvement.

Greater public awareness of sepsis and patient education may help people to be aware of their own risk factors and recognise the early signs of sepsis, enabling them to seek medical attention earlier. Work on this has been undertaken in other countries, including the UK and Australia, where the ‘Just ask “could it be sepsis?”’ campaigns have encouraged people to ask health care workers whether their illness could be due to sepsis.

Next steps

Te Tāhū Hauora published the healing, learning and improving from harm national adverse events policy in July 2023, and it has been socialised across the health sector. This policy has a greater emphasis on consumer and whānau participation and system learning. It is hoped that, as health organisations enact this policy, there will be a greater focus on system safety and consumer-focused recommendations in future adverse event reviews.

This report highlights the need for a national sepsis quality improvement programme to improve the early recognition and treatment of sepsis in both community and hospital settings. Te Tāhū Hauora is working with Sepsis Trust NZ to develop a package of quality improvement tools that can be tested and implemented within health organisations.

Conclusion

Early recognition and treatment improves outcomes for people with sepsis. A national sepsis improvement programme is an opportunity to increase awareness of sepsis risk factors and early signs and to standardise sepsis management where possible. It is an opportunity to help both clinicians and consumers think ‘could this be sepsis’ and to support earlier recognition and treatment.

Appendix 1: Full list of recommendations contained within the adverse event reports

Recommendation focus	Number	Examples
Sepsis-specific		
Implement or improve a sepsis screening tool/pathway	11	• Implement a service-specific sepsis pathway • Implement a whole-of-hospital sepsis programme • Roll out an existing sepsis pathway to other parts of the hospital
Education or training about sepsis	5	• Education for clinicians about recognition and management of sepsis
Early warning systems and patient deterioration		
Implement/improve early warning or patient deterioration systems	9	• Implement NZEWS, MEWS, PEWS or NOC-NEWS • Reinforce assessment of whānau concern • Review response processes
Kōrero Mai	4	• Implement or review implementation of Kōrero Mai programme for patient, family or whānau escalation of concerns
Education/training about EWS or patient deterioration	8	• In-person or simulation training about managing deteriorating patients • Completion of e-learning about EWS • Competency in basic and advanced life support
Policy/guidelines	10	• Review escalation pathway • Introduce electronic vital sign charts
Infection prevention and control (IPC)		
Process improvements	4	• Anti-staphylococcus bundle • Screening/communication of multi-drug-resistant organisms
Follow-up audits	5	• Audit compliance with anti-staphylococcus bundle • Ongoing surgical site infection surveillance
Policy/guidelines	6	• Develop, review or standardise antibiotic guidelines
Consumer-focused	2	• Discharge information about prevention of surgical site infection
IV therapy		
Process improvements	10	• PIVC improvement project such as ACC's 'know your IV lines' • Use of extension sets for PIVC

		• Earlier insertion of PICC
Education/training	5	• Education about insertion and management of peripheral and central IV lines • Credentialling for insertion of PIVC
Policy/guidelines	5	• Modifications to CLAB form
Follow-up audits	6	• Ongoing CLAB auditing • PIVC point prevalence survey
Consumer focused	1	• Written advice about signs of PIVC infection given to patient at discharge
Communication, escalation and teamwork		
Communication processes between clinicians	19	• Team huddles • SMO–SMO communication for unstable/complex patients • Handover processes
Escalation processes	16	• Processes for escalation from RMO-to-SMO • Escalation processes for positive blood cultures • Escalation pathways within emergency departments, intensive care units and patient-at-risk services
Teamwork processes	2	• Multidisciplinary assessment/stabilisation of severely unwell patients
Teamwork/communication training	2	• Training around speaking up for safety • Human factors education programme about decision-making
Consumer focused	2	• Re-engaging people who don't attend clinic • Improving phone advice processes
Other recommendations		
Process improvements	17	• Pre-hospital availability of antibiotics for time-critical situations • Patient flow • Implement shared goals of care • Service-specific process improvements
Laboratory processes	4	• Review processes for notification of positive blood culture results
Environmental or equipment upgrades	7	• Improvements to electronic systems • Upgrades of physical equipment or environment
Staffing resource	11	• Review staff numbers and rosters • New roles/increased staffing resource
Education and training	17	• Cultural safety training • Service-specific training

Alerting/reminding staff	31	• Present case study at morbidity and mortality or service meetings • Newsletters or other written communications • One-to-one meetings with staff
Other consumer-focused recommendations	2	• Develop/provide written consumer information
Other audits	5	• Service-specific audits
Other policy/guideline or form	21	• Standardise fluid balance charts • Review guidelines for premature rupture of membranes • Service-specific guidelines
Actions required by clinicians	8	• Non-specific recommendations for actions that clinicians should be doing (eg, improve documentation)

Abbreviations: ACC = Accident Compensation Corporation; CLAB = central line-associated bacteraemia; EWS = early warning system; IPC = infection prevention and control; IV = intravenous; MEWS = Maternity Early Warning System; NEWS = Newborn Early Warning Score; NOC = Newborn Observation Chart; NZEWS = New Zealand Early Warning System; PEWS = Paediatric Early Warning System; PICC = peripherally inserted central catheter; PIVC = peripheral intravenous catheter; RMO = resident medical officer; SMO = senior medical officer.

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