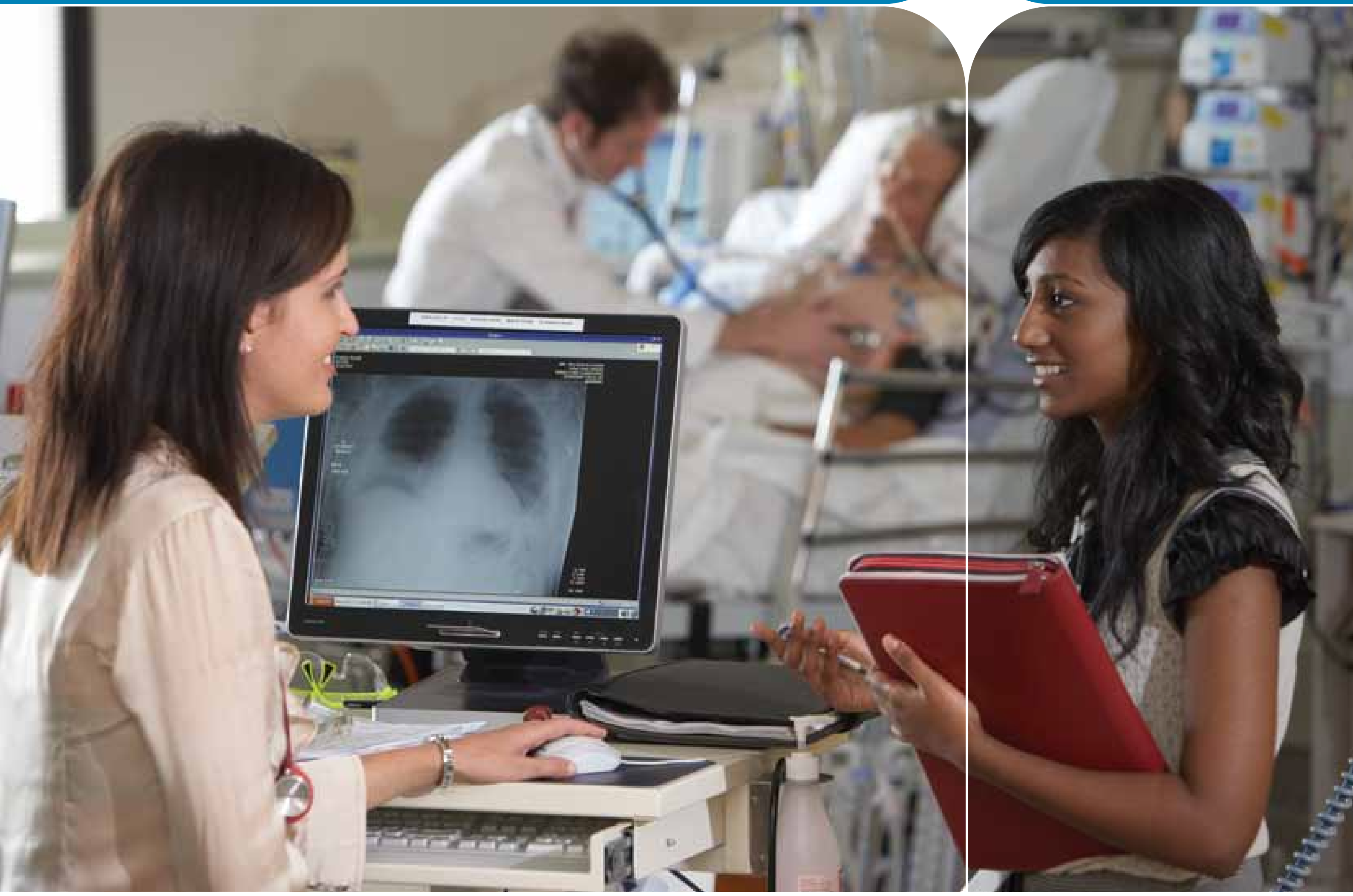
Department of Health

health

Ten years of intensive care in Victoria (2001–02 to 2010–11)

Victorian Intensive Care Data Review Committee



State Government Victoria

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Contents

About this report

Intensive care services are an essential part of the Victorian hospital system, providing care for patients with life-threatening illnesses, injuries and complications that require sophisticated medical management and a high level of staffing and resourcing.

These services seek to operate according to the following principles:

- delivery of high-quality patient-centred care
- delivery of timely and accessible care
- delivery of safe, appropriate and evidence-based care
- ensuring a responsive, flexible service system
- integrating intensive care services within the continuum of healthcare
- ensuring the supply of an appropriately trained and flexible workforce
- ensuring efficient and appropriate utilisation of finite intensive care resources
- utilising information technology and data management solutions
- supporting continuous improvement, collaboration, innovation and research.

The past 10 years have seen significant progress in each of these areas, resulting in improved outcomes for critically ill people. *Ten years of intensive care services in Victoria* documents this journey from the points of view of various stakeholders, including the Department of Health, intensive care services and patients and families. It highlights a number of significant changes and developments in the delivery of intensive care services over this period. It also describes trends in service and resource utilisation, and demonstrates the human face of intensive care through the stories of staff and patients.

The report reviews service information for the 10-year period from 2002 to 2011, drawing on data from a number of sources including registries managed by the Australian and New Zealand Intensive Care Society Centre for Outcome and Research Evaluation (ANZICS CORE) and the Department of Health's Victorian Admitted Episodes Dataset (VAED) (see overleaf). These datasets enable monitoring of service capacity, utilisation and outcome, which in turn supports quality improvement activities within the sector.

In Victoria our population of approximately 5.7 million is served by 25 public sector and 14 private sector intensive care units (ICUs). Public sector services are the main subject of this report and include seven tertiary referral hospitals (six metropolitan and one regional), seven other metropolitan hospitals and 11 other regional/rural services.

Data sources for monitoring intensive care services in Victoria

Subsequent sections of this report provide detailed statistical analysis relating to Victorian intensive care service delivery and outcomes over the past 10 years. The data are from four sources:

ANZICS CORE Adult Patient Database (APD)

The APD holds one of the largest not-for-commercial intensive care comparative datasets in the world, and is used to benchmark performance, to increase the understanding of casemix throughout Australia and New Zealand, and for research. The data fields collected include demographic details, admission and discharge details, outcomes, and clinical information to calculate severity of illness. Each ICU admission is allocated a single admission diagnosis that is used to calculate a predicted risk of hospital mortality for each patient. Data are collected by each hospital and submitted quarterly to ANZICS CORE, which produces reports for each contributing unit and jurisdiction. These reports summarise the performance of a particular site for a defined time period and compare it with other Australian and New Zealand sites for the same period. Summary statistics include age, gender, length of stay and severity of illness.

ANZICS CORE Critical Care Resources (CCR) registry

The CCR registry surveys all ICUs in Australia and New Zealand on a yearly basis. The survey focuses on the distribution and features of critical care units, medical and nursing workforce data and selected quality indicators. Details requested include the number of admissions to ICU, the hours or days of ICU care provided, and mechanical ventilation hours. Staffing profiles of medical, nursing and allied health staff are reported. This initiative is unique within Australia and New Zealand and provides valuable information for planning intensive care resources.

ANZICS CORE Paediatric Intensive Care (ANZPIC) registry

The ANZPIC registry is similar to the APD but collects information on admissions to paediatric ICUs in Australia and New Zealand.

Victorian Admitted Episodes Dataset

The VAED is an administrative dataset maintained by the Victorian Department of Health that contains data on all inpatient admissions. The database has a range of data elements specific to critical care including the hours of intensive care and the hours of mechanical ventilation. VAED data are collected by health information managers at public hospitals throughout Victoria, who enter data on all patients discharged from hospital using the medical history and computerised hospital information systems to determine data values. The number of ICU admissions recorded in the VAED has always differed from the number in the APD. Some explanations for these differences have been identified:

- Most regional hospitals include coronary care unit (CCU) admissions, while a few exclude CCU and high dependency unit (HDU) admissions from their VAED.
- Readmissions to ICU are recorded in the APD but not in the VAED.

Intensive care – past, present and future

Intensive care is where the sickest patients in the hospital are treated. In most cases their illness has resulted in severe dysfunction or failure of one or more vital organs; ICUs provide the technology to support the failing organs while the underlying illness is treated. The services manage a diverse range of patients; some have a major medical illness such as stroke, heart failure or heart attack, or severe infection; others need support to overcome problems associated with major surgery or following trauma. Many patients are not able to breathe on their own and require artificial ventilation. Other organ systems such as heart, circulation and kidneys may also need support.

Intensive care services have evolved over time in response to particular circumstances as well as to new medical and surgical developments. They developed from a recognition that seriously ill or injured patients could benefit from closer attention, and at a time when improvements in technology, monitoring and therapeutics enabled greater numbers of these patients to survive.

In Victoria the past 10 years have seen significant increases in the capacity of intensive care services to meet the rising demand associated with a growing population. In addition there has been a significant reduction in both observed hospital mortality and risk-adjusted mortality for ICU admissions, which suggests improved efficacy of care for critically ill patients.

The improvements in service capacity and patient outcomes are associated with a number of substantial initiatives, including those focused directly on intensive care services as well as those impacting more broadly on the healthcare system. Some of these are described briefly in this section, and summarised in Figure 1.

Milestones in intensive care history

- In the 1850s, during the Crimean War, Florence Nightingale insisted that the most seriously ill patients were placed in beds near the nurses' station so they could be watched more closely.
- In 1923 a special unit was opened for critically ill postoperative neurosurgery patients at the Johns Hopkins Hospital in the United States, using specially trained nurses to monitor and manage them.
- In 1930 a combined recovery/intensive care ward was established at the University of Tubingen in Germany; by 1960 almost all hospitals had recovery units attached to their operating theatres.
- During World War II, specialised shock units provided resuscitation for the large numbers of severely injured soldiers.
- In the 1950s polio epidemics led to the establishment of respiratory units for large-scale mechanical ventilation.
- In 1958 a four-bed shock ward was opened in Los Angeles.
- In the 1960s and 1970s the Vietnam War prompted a further evolution in trauma care specialisation and the development of shock/trauma units.
- The first ICU in Melbourne was opened in 1960.

Facts and figures – Victorian public intensive care activity, 2002 to 2011

- Over this 10-year period nearly 200,000 patients have been treated in Victorian ICUs: 182,062 adult patients and 16,672 paediatric patients.
- Adult admissions to ICU increased over this period, from 16,329 in 2001–02 to 20,484 in 2010–11, an average increase of 2.3% per year, or 0.7% per year after adjusting for the rise in population numbers. Over the same period, paediatric admissions increased from 1,412 to 2,006.
- The 10-year period has seen an average increase in the number of beds by 2.6% per year, or 1.5% per year adjusted for population increase. The number of available beds has increased to meet the increasing demand, with an additional 51 beds funded since 2006.
- The seven tertiary hospitals care for 50% of all adult admissions to public hospital ICUs; seven metropolitan units care for 27% and regional/rural units care for 23%.
- While 42% of patients admitted to ICU receive mechanical ventilation, these patients occupy 71% of ICU beds.
- Most adult ICU admissions come from the operating theatre after major surgery (42% in 2010–11), followed by admissions from emergency (32%) and inpatient wards (18%). Patients transferred from other hospitals account for approximately 8%.
- Surgery for coronary artery bypass grafts remains the most common diagnosis associated with admission to ICU, however this declined from 13% of all ICU admissions in 2001–02 to 7% in 2010–11.
- The proportion of admissions from operating theatre has declined from 48% to 42%, reflecting advances in medical therapy, such as the introduction of percutaneous cardiac intervention.

The above figures are derived from the Victorian Admitted Episodes Dataset (VAED)

Source: VAED

Figure 1: Highlights in the development of ICU services in Victoria

Policy and infrastructure

- 2012 — *Intensive care service planning framework* (DH), 2011
- 2011 — *Minimum standards for intensive care units* (CICM), 1994 (latest revision 2011)
- *A framework for the intensive care unit liaison nurse in Victorian health services* (DH), 2010
- 2010 — *Intensive care clinical indicators* (ACHS), 1998 (latest revision 2010)
- National DonateLife Network established 2010
- 2009 — *Victorian intensive care services: future directions* (DHS), 2009
- 2008 — *Time-critical defined transfer guidelines established* (DH), 2008
- 2007 — Adult Retrieval Victoria established under Ambulance Victoria, 2007
- 2006
- 2005
- 2004
- 2003
- Victorian Intensive Care Data Review Committee established, 2002
- 2002 — Victorian Intensive Care Advisory Committee established, 2002
- 2001 — *Planning for intensive care in Victoria* (DH), 2001
- 2000 — Victorian State Trauma System established, 2000
- 1999 — Intensive care research coordinator positions formalised, from 1999

Clinical advances

Advances in ICU-specific therapies

- Therapeutic hypothermia in the treatment of cardiac arrest
- Early uptake of haemofiltration and the capacity to perform this intervention in all ICUs
- Use of low tidal volume mechanical ventilation for patients with lung injury
- Non-invasive ventilation in place of more invasive ventilation modes for patients with respiratory conditions such as chronic obstructive pulmonary disease (COPD)
- Use of extracorporeal membrane oxygenation (ECMO) in a broader range of diseases, including cardiac conditions, sepsis and pneumonia; and use to greater effect during patient transport
- Focus on early identification of the deteriorating patient, including the introduction of medical emergency teams (METs)
- Use of protocols of care to support consistent and improved approaches to identify and manage sepsis

Other therapeutic advances impacting on ICU

- Minimally invasive surgical techniques
- Interventional cardiology including percutaneous cardiac intervention
- Interventional radiology, including percutaneous endoluminal stenting of abdominal and thoracic aneurysm
- Rapid sequence intubation performed by ambulance crews

ACHS = The Australian Council of Healthcare Standards; CICM = College of Intensive Care Medicine; DH = Department of Health (Victoria); DHS = Department of Human Services (Victoria)

Planning for improvement

Several planning initiatives have supported ongoing improvements in service delivery for intensive care services in Victoria. In 2001 the Department of Health released a review, *Planning for intensive care services in Victoria*, that examined the level of service and provided a basis for future planning. That report made recommendations in relation to workforce issues, data collection, resource allocation and funding. Resulting initiatives included funding of additional ICU beds and establishment of the Intensive Care Advisory Committee (ICAC) to advise on key issues impacting on intensive care services including:

- policy directions
- utilisation and capacity
- planning the distribution and roles of ICUs including regional/rural ICUs
- quality and safety of intensive care
- issues escalated from the Victorian Intensive Care Data Review Committee (VICDRC)
- standards, resources and equipment issues including information technology
- management processes and systems
- workforce issues
- supporting regional critical care services and strengthening links between metropolitan and regional/rural services
- the interface between intensive care services and other critical care services, such as CCUs.

In 2009 the department, in consultation with ICAC and key intensive care stakeholders, produced *Victoria's intensive care services: future directions* to inform further development of services in the state. The document identified three priorities, which have continued to guide service improvement:

- sustainability: building a sustainable system
- access: the right level of patient care when required
- quality: safe and effective intensive care services.

It also identified the need for a service planning framework and methodology for organising and distributing accessible intensive care services in the state. This work was undertaken in 2010 and the *Intensive care service planning framework* was published in February 2011. This forecasting methodology is being used by the Department of Health to guide decision making regarding allocation of intensive care capacity and capital planning, as well as planning to achieve further integration of the overall system, including trauma and retrieval.

Planning for extraordinary increases in demand for intensive care services has also been undertaken in order to ensure appropriate capacity and capability in case of a disease pandemic or major mass casualty event such as a bushfire or plane accident.

Clinical practice advances

Several advances in patient care have contributed to improved outcomes in ICU. Many of these are interventions that are performed elsewhere in the hospital or en route, and have indirectly improved the outcomes of patients who come through the ICU, for example:

- minimally invasive surgical techniques such as laparoscopic and endoscopic abdominal and thoracic surgery
- interventional cardiology including percutaneous cardiac intervention (PCI) for acute myocardial infarction, which is instigated instead of urgent cardiac surgery
- interventional radiology, including percutaneous endoluminal stenting of abdominal and thoracic aneurysm
- rapid sequence intubation performed by ambulance crews.

Advances in ICU specific therapies include:

- therapeutic hypothermia in the treatment of cardiac arrest
- early uptake of haemofiltration and the capacity to perform this intervention in all ICUs
- use of low tidal volume mechanical ventilation for patients with lung injury
- non-invasive ventilation in place of more invasive ventilation modes for patients with respiratory conditions such as chronic obstructive pulmonary disease (COPD)
- use of extra corporeal membrane oxygenation (ECMO), also known as a heart-lung machine, in a broader range of diseases, including cardiac conditions, sepsis and pneumonia; it is also being used to greater effect, including during patient transport
- focus on early identification of the deteriorating patient, including the introduction of medical emergency teams (METs), and
- use of protocols of care to support consistent and improved approaches to identify and manage sepsis.

Rick's story

On Saturday 7 February 2009, Victoria suffered its worst bushfire ever. Rick, a middle-aged farmer, escaped his burning home and hid with friends and family initially in a car and then in a local dam. When emergency services reached him during the night he was unconscious, with burns to 40% of his body. A number of his family members had already died. He was transferred to The Northern Hospital for initial resuscitation and then directly to the regional burns centre at The Alfred. He underwent emergency surgery and was admitted to the ICU.

The night he was admitted the state trauma and emergency retrieval services coordinated transfers of multiple critically ill patients around the state. Many metropolitan and tertiary ICUs took in extra patients without burns injuries to provide additional ICU capacity at The Alfred so patients like Rick could be admitted.

Rick spent nearly two weeks attached to a ventilator in the ICU. It was almost another week before he was discharged from ICU to the burns ward and he spent another month in hospital before eventually returning to his home town.

The significant advances in cardiorespiratory support over the past 10 years are reflected in ICU patient outcomes. In 2000, most deaths in ICUs were due to cardiovascular and respiratory causes; however, in 2010 the most common mechanism of death was associated with irreversible injury to the brain following trauma, brain haemorrhage, stroke or lack of oxygen after a cardiac arrest.

Not all advances are technologically complex. The past decade has seen a strong focus on:

- prevention of hospital-related infection, with well-established and rigorous infection-prevention processes and surveillance
- early identification of the deteriorating patient, development of rapid response systems and METs
- improving the transition of patients and their families in and out of ICU.

These clinical advances are coupled with system improvements such as the development of the Victorian Major Trauma Service, with centralisation of trauma care to major trauma hospitals (refer page 14).

We have also seen an increased emphasis on the emotional needs of patients and their families, and the importance of communication and involvement in decision-making including end-of-life care and providing opportunities to avoid futile or harmful therapies. This is one of a number of factors that has driven a more holistic approach to care, which is supported by a highly skilled multidisciplinary clinical team, including specialist intensivists and critical care nurses, as well as physiotherapists, pharmacists, dietitians, pastoral care associates, microbiologists and medical technologists.

Critical care research

Innovation and quality improvement in Victorian intensive care services are facilitated through their active involvement in clinical research. The intensive care community forms part of a network of collaborative intensive care researchers in Australia and New Zealand, which has a strong track record in designing and executing high-quality multicentre randomised controlled trials. Fourteen Victorian ICUs participate in the network (ANZICS Clinical Trials Group) and many of the trials have resulted in better outcomes for patients as well as reductions in the cost of care through reduced use of expensive but ultimately ineffective treatments.

Victorian intensive care research coordinators have played a key role in successfully completing several large ANZICS Clinical Trials Group studies over the past decade. In addition, individual Victorian ICUs have undertaken and published research projects that have advanced the knowledge, delivery and monitoring of critical care medicine in areas of cardiac arrest, METs, transfusion practices and organisation of care. (More information on research, including references to relevant studies, is detailed in Appendix 2)

Monica's story

A 30-year-old woman, 31 weeks pregnant, was admitted to intensive care at a private metropolitan maternity hospital for management of shortness of breath and pre-eclampsia. Two days later she had a cardiac arrest and received cardiac resuscitation (CPR) en route to the operating room for an emergency caesarean section.

While she was still undergoing CPR, a baby boy was successfully delivered by caesarean section and was intubated and transferred to the neonatal ICU. He subsequently did well and was discharged home.

The mother responded to resuscitation but had several episodes requiring CPR and cardioversion. Urgent consultation with a tertiary hospital resulted in an intensivist being sent to help in the operating room and to assist rapid transfer of the patient to the tertiary ICU.

Echocardiography revealed global cardiac depression, not in keeping with massive pulmonary embolism, which until then had been the working diagnosis. Monitoring lines and cardiac support medications were instituted; the patient was admitted to the ICU, ventilated and placed on medication to support her blood pressure. Over the next three days her cardiac condition stabilised, the diagnosis of peripartum cardiomyopathy was made, and a good neurological recovery occurred.

The patient was extubated two and a half days after admission to the ICU and was transferred to the CCU for management of her cardiomyopathy. She was ultimately discharged home.

ICU without walls – intensive care workforce models

The intensive care service is now viewed less as a 'location' and more as a source of critical care expertise, with intensive care staff reaching out to other parts of the hospital to provide timely advice and care for deteriorating or recovering patients. This is due to the increase in complexity of patients now occupying hospital wards. In addition, ICUs act as part of the statewide critical care system, forming a network that, by working together in a coordinated way, can better service the diverse and growing need for this high level of care (see *Critical care retrieva*l on page 12). In this way, intensive care is focused less on where the patient is located and more on their individual needs, which results in more timely care and improved access.

Intensive care clinicians have had a pivotal role in developing emergency response teams. These services, initially in the form of cardiac arrest teams, have been provided in most health services for several decades. Throughout the 2000s METs have been progressively implemented throughout most Victorian health services, and are considered to have contributed to reduced rates of cardiac arrest.

The ICU liaison nurse role has also emerged and evolved over the past decade, supported by Department of Health funding and initiatives to support definition and consistency of the role (see *A framework for the intensive care unit liaison nurse in Victorian health services, 2010*). The role aims to better manage the transition of patients from the ICU to the ward and to support the treatment of deteriorating or complex patients in the ward environment, avoiding unnecessary ICU admission, or facilitating their admission to ICU. In this way the ICU liaison nurse acts as a bridge between the skills and resources of the ICU and the ward environment, supporting continuity of care and patient flow. The role also includes formal and informal education of ward staff and support for the families of critically ill patients, including end-of-life discussions and palliative care. These roles also complement the recent focus on managing the deteriorating patient as evidenced in the new Australian Commission of Quality and Safety in Healthcare standards.

Standards, monitoring and quality improvement

The operation and quality of intensive care services nationally are supported by a number of clinical standards including:

- *Minimum standards for intensive care units* developed by the College of Intensive Care Medicine, which provide guidance in relation to staffing, operation, structure, equipment and monitoring
- the Australian Council of Healthcare Standards' *Intensive Care Clinical Indicators*, which were first established in 1998 and are regularly reviewed, most recently in 2010. Health services contribute indicator data voluntarily and, in 2012, 89% of Victorian ICU services contributed data (see www.achs.org.au).

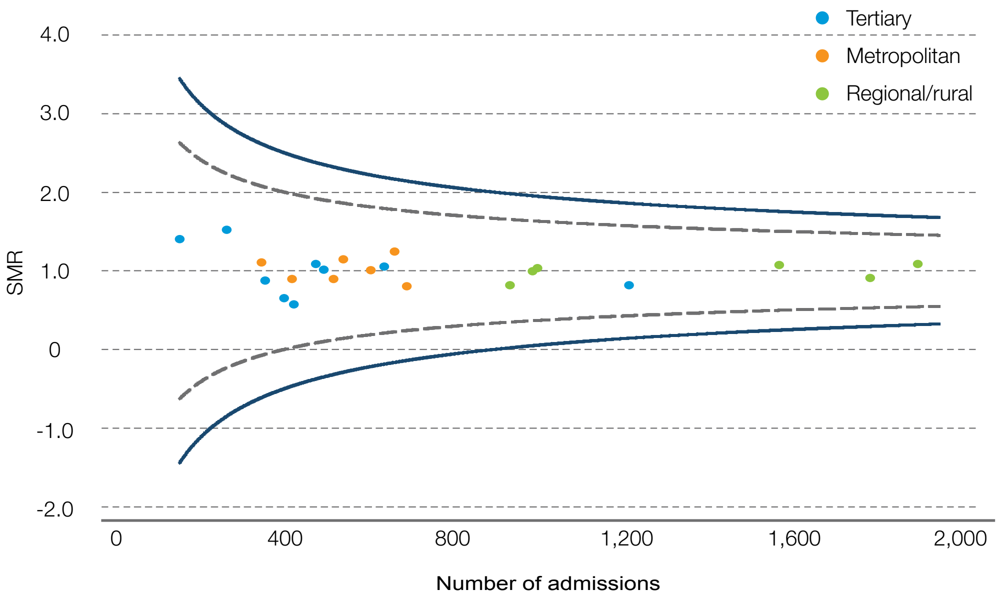
Victorian Intensive Care Data Review Committee

Monitoring of intensive care utilisation and outcomes has been an important component of service improvement and collaboration in Victoria. The VICDRC was established in February 2002 as a joint working group of the Department of Health and ANZICS to share information and to advise the department, Intensive Care Advisory Committee and the Victorian Quality Council on the safety and quality of intensive care services. The committee meets quarterly to review data on activity in ICUs and produces an annual report.

Both ANZICS CORE and the VICDRC have developed governance procedures to monitor and report on patient outcomes at each health service. The current VICDRC process includes examination of standardised mortality ratios (SMR) and quality control charts for each ICU utilising two independent and complementary benchmarks and risk-adjustment tools – the Acute Physiology, Age, Chronic Health Evaluation, third version (APACHE-III-J) model and the Critical Care Outcome Prediction Equation (COPE) model, based on data submitted by each health service (Figure 2) (see also *Trends in intensive care outcomes* on page 41).

The ANZICS CORE outlier management program is a national program and is designed to work with local jurisdictional committees such as the VICDRC. In the case of Victorian units, ANZICS CORE works with the VICDRC to provide any additional analysis required to investigate the outlier status of a unit, which includes: an in-depth analysis of data quality and casemix; audit of data collection at the local site; and the comparison of APD data with other data sources such as the CCR registry and the VAED.

Figure 2: Example of funnel plot showing standard mortality ratios versus number of admissions by site for a given period



Source: APD

Critical care retrieval

Outcomes for critically ill patients depend on timely access to definitive care, thus patient transfer (medical retrieval) is a key aspect of the statewide intensive care system. Major developments over the past 10 years have resulted in a more integrated, comprehensive, efficient and effective system, including Adult Retrieval Victoria (ARV), the Paediatric Emergency Transfer System (PETS) and the Neonatal Emergency Transfer System (NETS).

The first formal adult retrieval service in Victoria was established in 1993 by the Office of the Coordinator of Critical Care Services – the Medical Emergency Adult Retrieval Service (MEARS). Following a major review of the trauma and emergency services in 1999, the Victorian Adult Emergency Retrieval and Coordination Service (VAERCS) was established in 2001 at St Vincent's Hospital. After a Department of Health review in 2006 the service transitioned to Ambulance Victoria in 2007, forming ARV as a separate business unit.

Key aspects of ARV's service include the following.

Critical care telephone advice

Critical care coordinators provide 24/7 advice on the clinical care of critically ill patients irrespective of whether or not medical retrieval is required.

Retrieval of critically ill and time-critical patients

The critical care team evaluates the clinical and practical circumstances of each case. If a transfer is necessary, transport and appropriate clinical staff are organised to accompany the patient and a suitable critical care bed is arranged at the receiving hospital. More than half of the transfers are undertaken by air transport.

Photograph by Craig Silltoe, The Age

Critical care bed access management

The availability of beds is monitored and managed throughout the state in order to optimise the use of resources. This is facilitated by the Retrieval and Critical Health (REACH) website (previously known as Victorian Critical Care Access website), which provides a close to real-time picture of the occupancy of critical care units.

Access has been further supported by detailed ARV clinical guidelines and the introduction of the *Time-critical defined transfer guidelines* in 2008. This system authorises ARV to nominate a hospital to receive a patient even when all critical care beds in the state are apparently filled. It guarantees that a patient in need of higher level critical care receives that care in an appropriate timeframe, thus providing a safety net in a system that, by nature and necessity, operates at a high level of occupancy.

Major trauma transfer and advice

While most major trauma patients are transferred directly from the scene of an accident to a major trauma service, some receive initial care at a smaller hospital and require subsequent transfer. ARV manages this service, connecting referral hospitals to appropriate receiving trauma services to ensure timely access to trauma care. In 2011 more than 80% of secondary major trauma transfers received ARV specialist clinician support and transfer coordination, compared with 15% prior to ARV's establishment.

All aspects of the service have benefited from an ongoing focus on workforce development, with more than 30 critical care and emergency medical specialists now associated with the service, and establishment of registrar positions in 2010. The service is supported by sophisticated technology systems, including the use of telehealth.

Paul's story

Emergency retrieval

Paul, a man in his mid-forties from a regional town, presented at his local hospital with severe community-acquired pneumonia, characterised by breathing difficulties, low white cell count, issues associated with potential bleeding and decreasing liver function.

He had become extremely difficult to ventilate, with little response to early therapy in the ICU, and there was significant concern that he would deteriorate further and die within 12–24 hours.

ARV was contacted to assist with care and coordination of transfer to a tertiary centre. Following initial assessment, ARV established a conference call with the ICU at The Alfred and with the referring ICU. An interim plan was established and a retrieval team was organised, comprising an ARV clinician, paramedic and two Alfred hospital specialists, trained to deliver the life-saving and sustaining ECMO treatment while undertaking the retrieval.

The team was flown urgently to the rural centre and established the patient on ECMO within five hours of the initial call, and he quickly stabilised. Transport back to Melbourne was facilitated by the specialised Complex Patient Ambulance, and he arrived at The Alfred in a stable condition within 12 hours of referral. After 13 days in intensive care he was discharged to the ward, and after further care was subsequently discharged to the community and to his family.

The Victorian State Trauma System

Linked closely to the retrieval system described above, the Victorian State Trauma System has developed over the past decade to facilitate the management and treatment of major trauma patients in Victoria. Established in 2000 in response to the report, *Review of trauma and emergency services 1999*, the system aims to reduce preventable death and permanent disability and improve patient outcomes by matching the needs of injured patients to an appropriate level of treatment in a safe and timely manner. The system works to have 'the right patient delivered to the right hospital in the shortest time'.

Key features of the state trauma system are:

- designation of two adult hospitals and one paediatric hospital as major trauma services (MTS) operating as the hub of an integrated system – this focuses trauma expertise in a limited number of hospitals and intensive care services
- statewide system organisation and management of trauma response
- trauma triage and transfer protocols
- enhanced retrieval and transfer services
- education and training
- research, service and technology developments
- quality management.

Since 2000 this framework has overseen significant improvements in the care of major trauma patients, with more than 80% of patients being treated at an appropriate MTS. A reduction in mortality rates has also been observed, with fewer than expected deaths according to international benchmarks, and reduced length of stay in hospital for this group of patients.

Organ donation

Intensive care services have played an important role in improving rates of organ and tissue donation in Australia. As part of a national reform agenda initiated in 2008 to implement a world's best practice approach to organ and tissue donation for transplantation, state-based organ donation agencies now form a coordinated DonateLife Network, overseen by the National Organ and Tissue Donation Authority.

Health service level initiatives have sought to increase capability and capacity to maximise donation rates and include:

- DonateLife liaison roles to support coordination with and within health services
- dedicated organ donation roles within health services including intensivists, emergency specialists and nurses (currently 22 health services in Victoria have these roles embedded, usually as part of clinicians' existing roles)
- education for staff involved in these dedicated roles as well as for all health services staff
- establishment of consistent best practice processes for various stages in the donation process including identifying potential donors, engaging and supporting families, and ensuring optimal physiological maintenance of donors in intensive care
- additional funding for hospitals to address the cost barriers associated with the donation process.

These activities are supported by broader efforts including ongoing community awareness and education.

In Victoria positive outcomes are evident in rates of organ donation, which have increased by more than 50% since 2005.

Cheryl's story

Cheryl was 62 years old when she suffered a cardiac arrest after choking on some food. She was resuscitated by MICA paramedics and was admitted to the ICU at Ballarat Base Hospital. She was treated with ventilation, adrenaline and cooling but continued to deteriorate. After four days in the ICU, Cheryl was diagnosed as brain dead.

Cheryl had previously spoken about organ donation to her family. So when the medical and nursing staff approached them, they consented to her becoming an organ donor. The donation surgery took place on a Saturday evening, and on Sunday morning a young man and a middle-aged woman received kidney transplants, which allowed both to come off dialysis. Another young man who was acutely unwell with hepatic failure received a life-saving liver transplant.

Looking to the future

The future is likely to see an increasing demand for ICU services in Victoria coupled with the need to work closely with other inpatient services to manage access to appropriate and timely treatment, and ensure optimal outcomes for patients. There is an increased interest in long-term outcomes, including long-term functional status and quality of life. The critical care community faces considerable clinical and organisational challenges to deliver the best possible care, within the limits of available resources, while also addressing the social and ethical issues that accompany the advent of new technologies.

The opportunities are also substantial. Commitment to future research and quality improvement is likely to realise additional improvements in patient care. From a clinical perspective an improved understanding and management of the physiological responses that contribute to organ failure in critically ill patients may lead to advances in care and delivery of services. For example, research into the genetic basis of disease may enable tailoring of therapies to better suit the specific needs of individual patients and improve outcomes.

Information technology presents an opportunity to improve quality of care, reduce risks and improve access to healthcare. Some health services are utilising telehealth to greater effect, with rural and regional centres being able to access advice from tertiary centres using devices as simple as an electronic tablet.

Collaboration between services, with funding and administrative agencies, and with research organisations, has and will continue to be important. Comprehensive and reliable data is a key component of service quality and access, and this will be required to monitor improvement in quality of care and patient outcomes.

Ten-year trends in intensive care delivery and outcomes, 2002 to 2011

Victorian intensive care capacity and activity

There are several ways in which intensive care services are provided. In addition to general ICUs, there are paediatric intensive care units (PICUs), combined ICU and CCUs or combined ICU and PICU. ICUs flexibly provide the required level care according to patient needs. This definition does not include stand-alone coronary care units, neonatal ICUs or ward-based HDUs.

In Victoria intensive care services are delivered by 25 public and 14 private critical care units, providing services to a growing and ageing population. Public services include 13 metropolitan and 12 regional/rural intensive care services. (Table 1, Figure 3 and Figure 4). Note that Barwon Health, while a tertiary service, is also classified as a regional health service.

PICUs are located at The Royal Children's Hospital and at Monash Medical Centre, where the paediatric unit is combined with the adult ICU.

Services vary in terms of their size, capabilities and type. For example, the seven public services based in tertiary hospitals support a range of subspecialties such as neurosurgery, cardiac surgery, paediatric and neonatal care, burns, organ transplantation, and trauma. Other metropolitan and regional/rural health services support a range of general surgical, medical and emergency services. Twelve units include a combined ICU and CCU; all but one of these is located in rural areas (Table 1).

This report covers all public services except for Albury Hospital, which did not begin reporting ICU data to the Victorian health system until October 2010. Data for Albury are included in the one year report (2010–11).

Separate sections describe service delivery and outcomes in paediatric services (page 50) and private intensive care services (page 54).

This section examines trends relating to:

- intensive care capacity
- intensive care utilisation
- patient characteristics including age and diagnosis
- severity of illness in terms of requirement for ventilation
- length of stay.

Table 1: Public intensive care services in Victoria

Hospital category	Hospital	Health service	Type of ICU
Tertiary	Austin Hospital	Austin Health	ICU
	Geelong Hospital	Barwon Health	ICU
	Monash Medical Centre	Monash Health	ICU/PICU
	St Vincent's Hospital	St Vincent's Health	ICU
	The Alfred	Alfred Health	ICU
	The Royal Children's Hospital	The Royal Children's Hospital	PICU
	The Royal Melbourne Hospital	Melbourne Health	ICU
Metropolitan	Box Hill Hospital	Eastern Health	ICU
	Dandenong Hospital	Monash Health	ICU
	Frankston Hospital	Peninsula Health	ICU
	Maroondah Hospital	Eastern Health	ICU/CCU
	Peter MacCallum Cancer Centre	Peter MacCallum Cancer Centre	ICU
	The Northern Hospital	Northern Health	ICU
	Western Hospital	Western Health	ICU
Regional/rural	Albury Hospital	Albury Wodonga Health	ICU/CCU
	Ballarat Base Hospital	Ballarat Health Services	ICU/CCU
	Bendigo Hospital	Bendigo Health	ICU/CCU
	Hamilton Hospital	Western District Health Service	ICU/CCU
	Horsham Hospital	Wimmera Healthcare Group	ICU/CCU
	Mildura Base Hospital	Mildura Base Hospital	ICU/CCU
	Latrobe Regional Hospital (Traralgon)	Latrobe Regional Hospital	ICU/CCU
	Sale Hospital	Central Gippsland Health Service	ICU/CCU
	Shepparton Hospital	Goulburn Valley Health	ICU/CCU
	Wangaratta District Base Hospital	Northeast Health Wangaratta	ICU/CCU
	Warrnambool Base Hospital	South West Healthcare	ICU/CCU

Note: Albury Hospital has always reported to APD but began reporting ICU data to the Victorian health system from October 2010. Data from this hospital for the full financial year 2010–11 is included in the 1 year report (2010–11) but not the 10 year report. Albury has also recently commenced contribution to the VAED.

Figure 3: Victorian public intensive care services – metropolitan

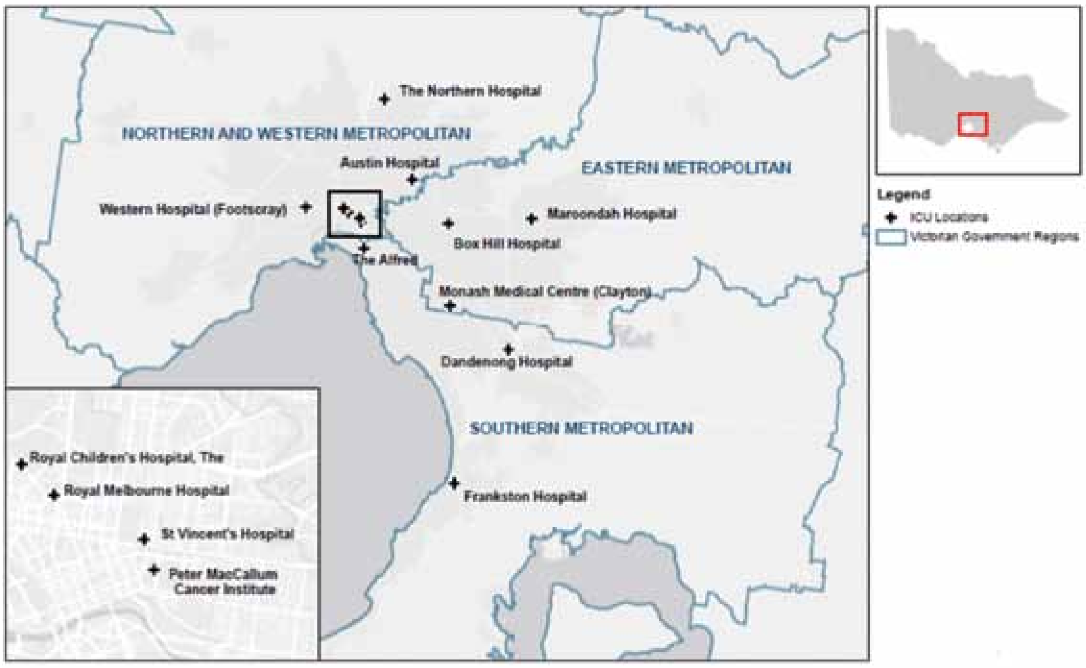
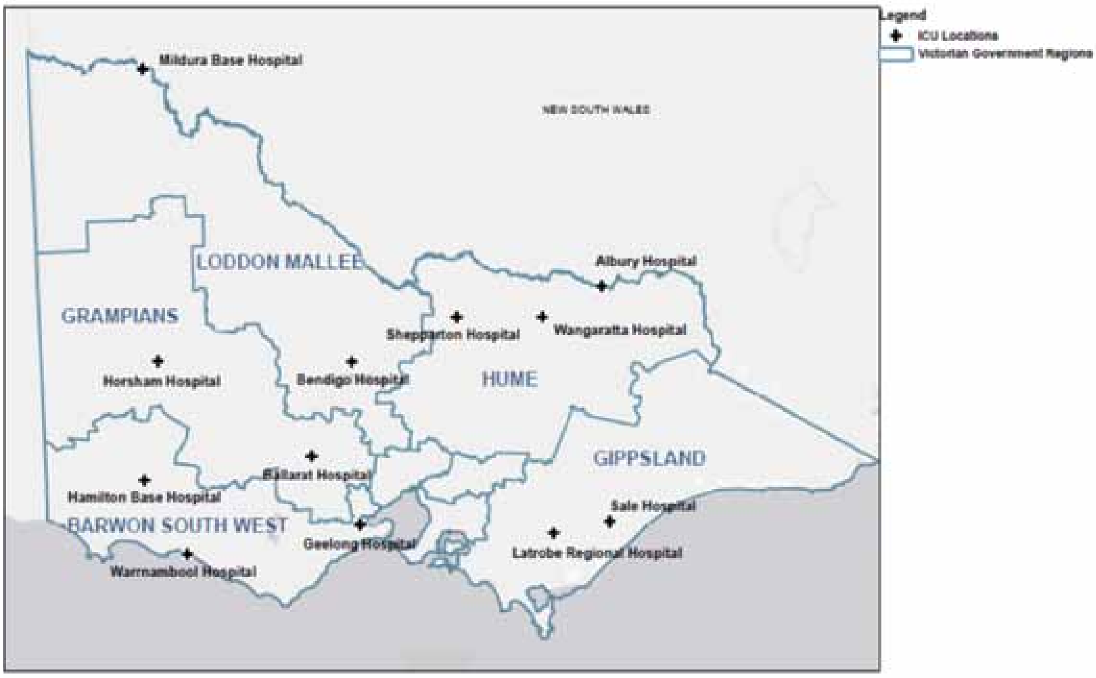


Figure 4: Victorian public intensive care services – regional/rural



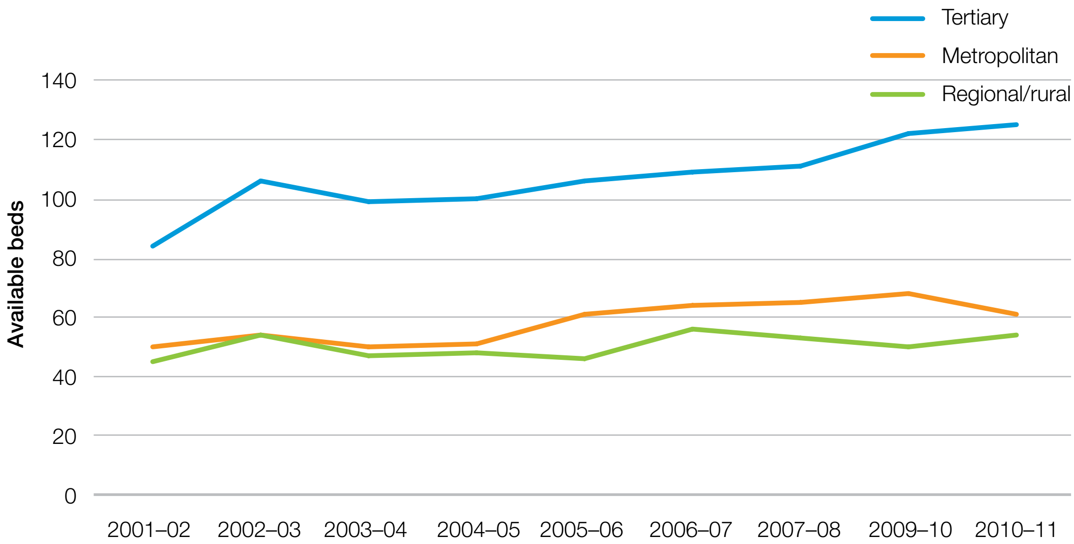
Intensive care capacity

There are a number of ways in which ICU capacity is measured: physical capacity, which is the number of physical beds in the system; operating capacity, which is the number of available beds in the system at any one time; and minimum operating capacity, which is the minimum level of operating capacity that health services agree to provide.

Minimum operating capacity for public services is set through the annual S*tatement of priorities* agreement each public health service signs. These requirements apply to tertiary and metropolitan services, and to a small number of larger regional services. The total minimum operating capacity was 204 by July 2010.

Actual operating capacity is higher than the minimum capacity and is self-reported to the APD (Table 2). Available beds have increased from 179 in 2001–02 to 240 in 2010–11. Much of this increase has occurred in tertiary hospitals, which have experienced a 49% increase compared with 22% for metropolitan and 20% for regional/rural services (Figure 5).

Figure 5: Available beds in Victorian public ICUs, by hospital category, 2001–02 to 2010–11



Source: CCR registry

Note: Not all services contribute to the CCR registry every year. Data was not available for 2008–09.

Table 2: Self-reported number of public adult physical, available and ventilator beds in Victoria, 2001–02 to 2010–11

ICU Level	Number	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11
Tertiary	Number of units	5	6	6	6	6	6	6	Data not available	6	6
	Physical beds (n)	116	139	134	133	140	140	142		147	149
	Ventilator beds (%)	86	96	115	116	127	126	124		140	136
		(74)	(69)	(86)	(87)	(91)	(90)	(87)		(95)	(91)
	Available beds (%)	84	106	99	100	106	109	111		122	125
		(72)	(76)	(74)	(75)	(76)	(78)	(78)		(83)	(84)
Metropolitan	Number of units	7	7	7	7	7	7	7		7	6
	Physical beds (n)	64	61	66	66	73	73	75		74	68
	Ventilator beds (%)	43	46	45	46	52	52	52		60	52
		(67)	(75)	(68)	(70)	(71)	(71)	(71)		(81)	(76)
	Available beds (%)	50	54	50	51	61	64	65		68	61
		(78)	(89)	(76)	(77)	(83)	(88)	(87)		(92)	(90)
Regional/rural	Number of units	9	9	8	8	9	9	9		10	9
	Physical beds (n)	54	61	51	53	53	64	64		63	58
	Ventilator beds (%)	26	26	26	28	32	33	33		33	29
		(48)	(43)	(51)	(53)	(60)q	(52)	(52)		(52)	(50)
	Available beds (%)	45	54	47	48	46	56	53		50	54
		(83)	(89)	(92)	(91)	(87)	(88)	(83)		(79)	(93)
Total	Number of units	21	22	21	21	22	22	22		23	21
	Physical beds (n)	234	261	251	252	266	277	281		284	275
	Ventilator beds (%)	155	168	186	190	211	211	209		233	217
		(66)	(64)	(74)	(75)	(79)	(76)	(74)		(82)	(79)
	Available beds (%)	179	214	196	199	213	229	229		240	240
		(76)	(82)	(78)	(79)	(80)	(83)	(81)		(85)	(87)

Source: CCR registry

Note:

- Not all services contribute to the CCR registry every year.
- Data was not available for the 2008–09 financial year.
- Bed numbers exclude coronary care beds.
- Albury Hospital has always reported to the CCR registry but began reporting ICU data to the Victorian health system from October 2010. Data from this hospital for the full financial year 2010–11 is included in the one-year report (2010–11) but not in the 10-year report. Albury has also recently commenced contribution to the VAED.
- The definitions used below may vary from those used by the Department of Health or other jurisdictional managers.

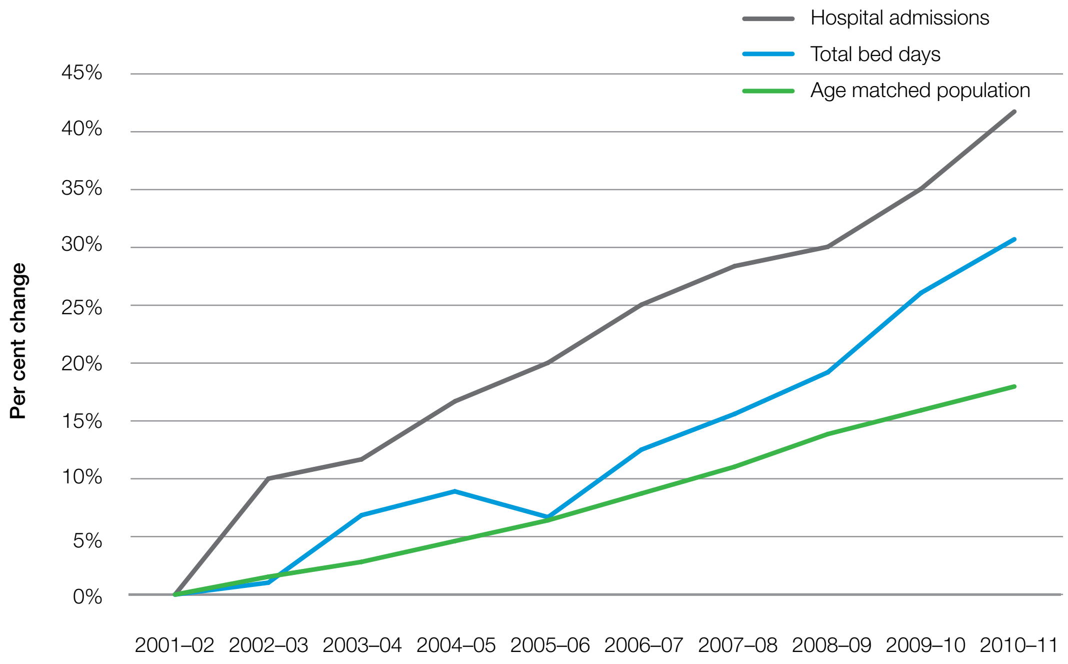
Physical bed:	A single patient care location fully configured to ICU standards – that is, an actual bed and not a bed space.
Ventilator bed:	A physical ICU bed plus ventilator.
Available bed:	A bed in use or immediately available for use by admitted patients as required. In ICUs this refers to a bed with advanced life support capability that is fully staffed. Available beds are averages over the financial year. They are self-reported in the CCR survey, and must be staffed and funded.

Intensive care utilisation

Utilisation of intensive care services is the level to which capacity is being used, and can also be measured in a number of ways, including by hours of intensive care delivered, by episodes or admissions to ICU (Figures 6, 8, 9, 10) or by the number of beds being used, expressed as bed days or occupied beds, which is total bed days divided by number of calendar days (Figures 6 and 7).

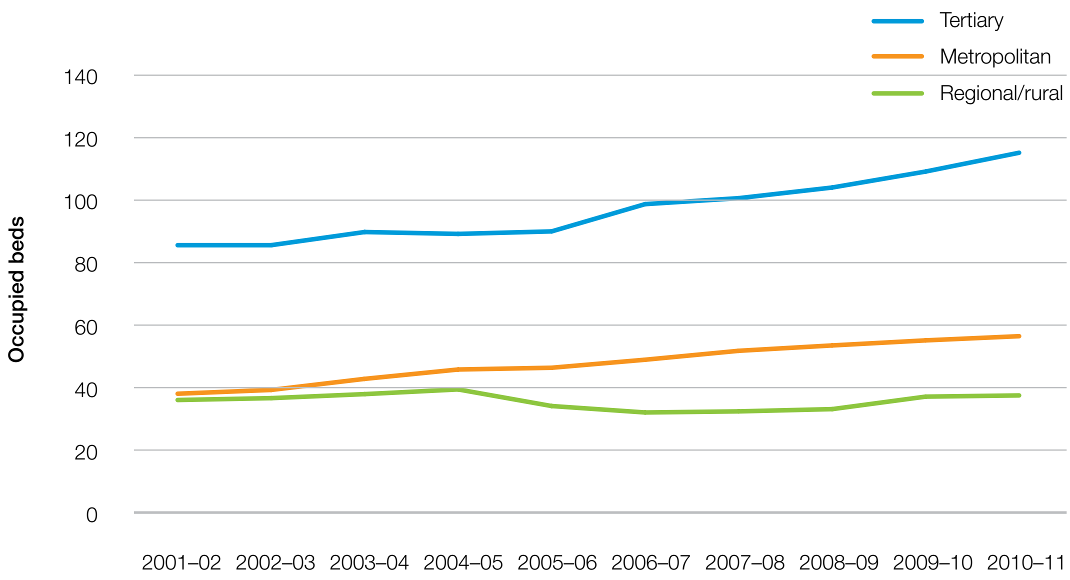
- Overall, adult admissions to ICUs increased from 16,329 in 2001–02 to 20,483 in 2010–11, an increase of 25% over that period (Figure 6). (Source: VAED)
- Growth in ICU bed days was slightly higher, increasing from 58,400 in 2001–02 to 76,300 in 2010–11, an overall growth of 30% (Figure 6). The more rapid growth in both bed days and admissions in the early 2000s correspond with a significant increase in beds at that time. (Source: VAED)
- Growth in adult hospital admissions and ICU bed days occurred at faster rates than population growth over the period (Figure 6).
- Self-reported data available through APD shows similar rates of increase for adult and paediatric admissions, although a number of hospitals failed to contribute data in 2001–02 and 2002–03, which is likely to account for the lower admissions in these years (Figure 8).
- Tertiary units consistently account for about 50% of ICU admissions, with the rest being equally divided between metropolitan and regional/rural units. Growth rates have been similar across the three categories (Figure 9).
- Patterns of growth within individual hospitals are shown in Figure 10. Large variations from year to year are generally due to failure to submit data to the APD.

Figure 6: Growth in total adult public hospital admissions, adult ICU bed days and age matched Victorian population, 2001–02 to 2010–11



Source: VAED

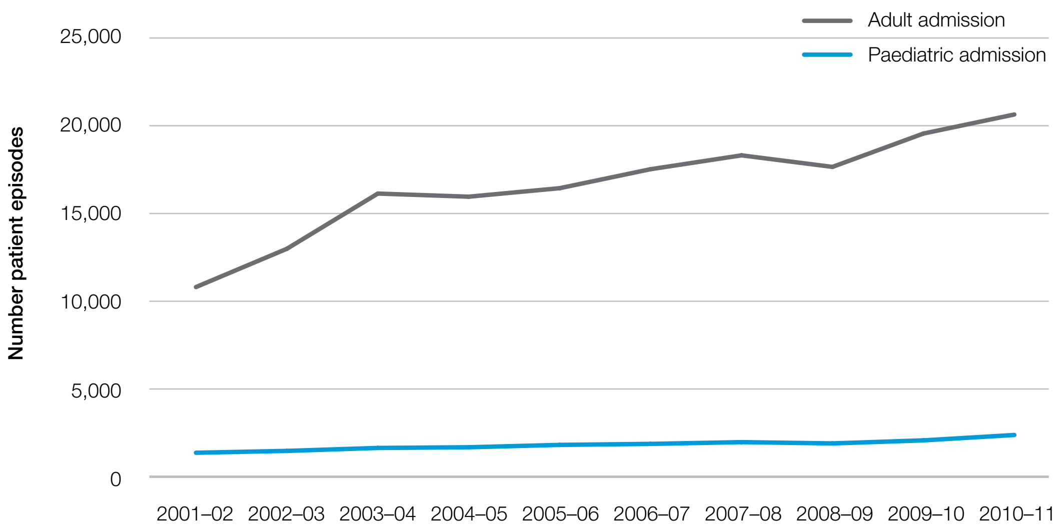
Figure 7: Occupied beds in Victorian public ICUs, by hospital category, 2001–02 to 2010–11



Source: VAED

Note: Occupied beds equals total bed days / number of calendar days.

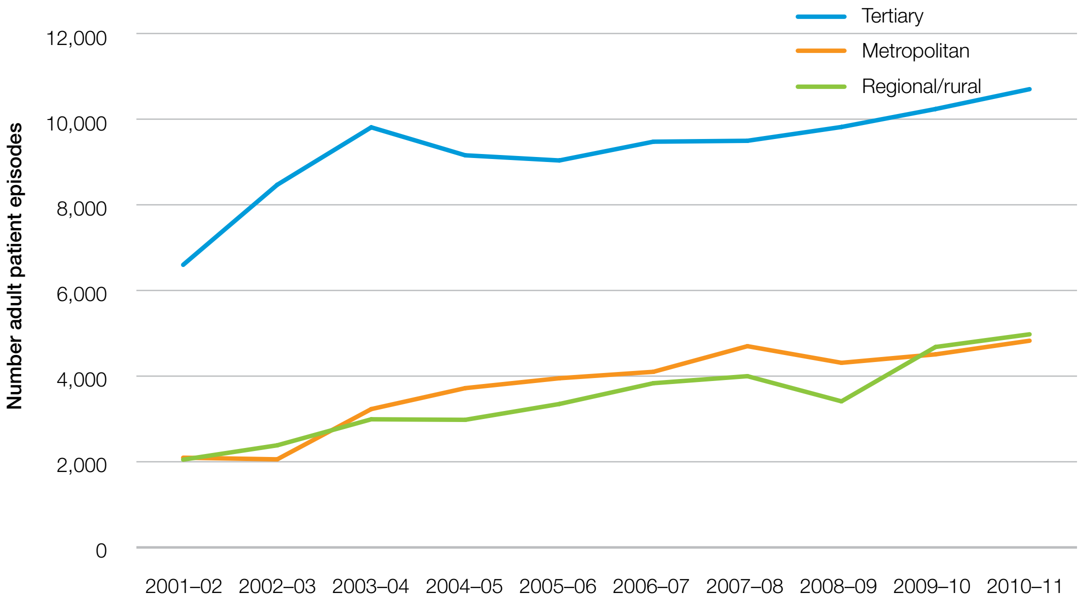
Figure 8: Number of Victorian adult patient episodes reported to the APD and number of paediatric episodes reported to ANZPICR, 2001–02 to 2010–11



Source: APD

Note: Not all hospitals report to APD every year, which is likely to explain the increase from 2001–02 to 2003–04.

Figure 9: Number of adult patient episodes reported to the APD, by hospital category, 2001–02 to 2010–11

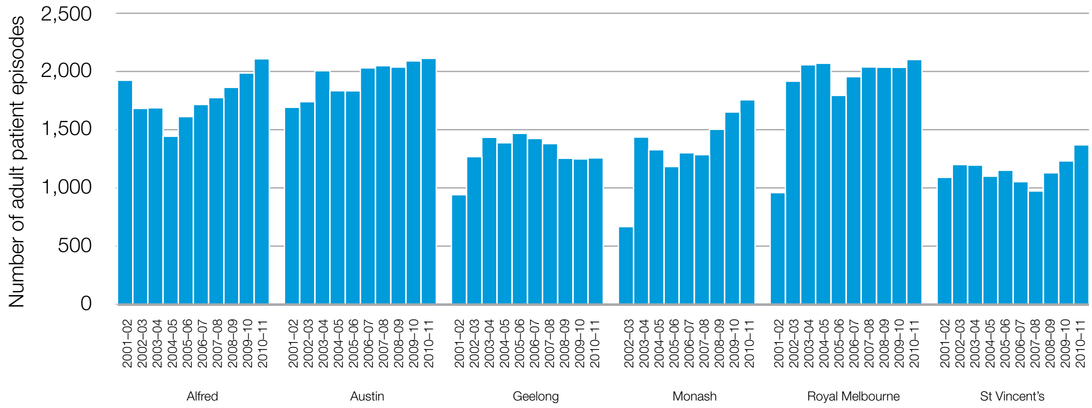


Source: APD

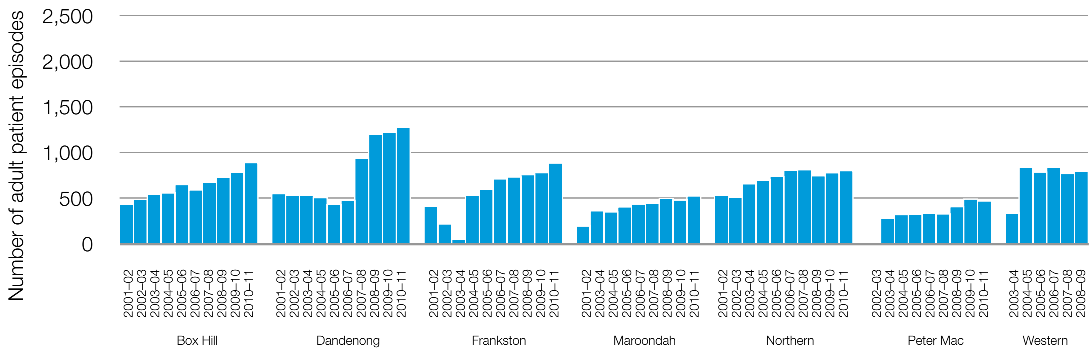
Note: Not all hospitals report to APD every year, which is likely to explain the increase from 2001–02 to 2003–04.

Figure 10: Number of adult patient episodes reported to the APD, by each adult intensive care unit, 2001–02 to 2010–11

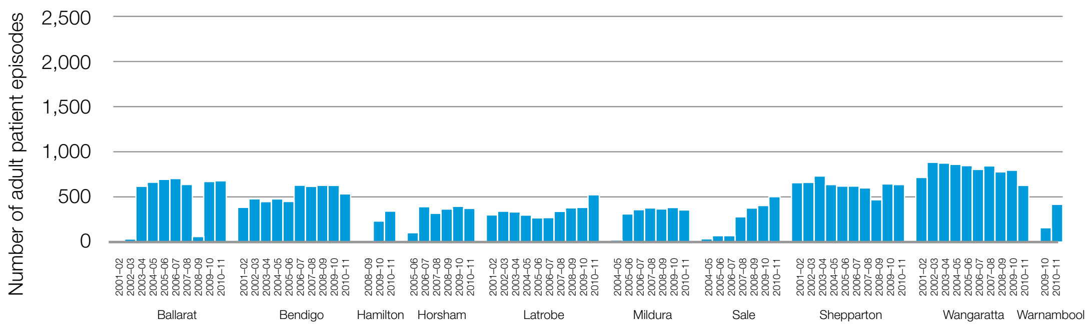
(a) Tertiary hospitals



(b) Metropolitan hospitals



(c) Regional/rural hospitals



Source: APD

Note: Not all hospitals report to APD every year

Patient characteristics

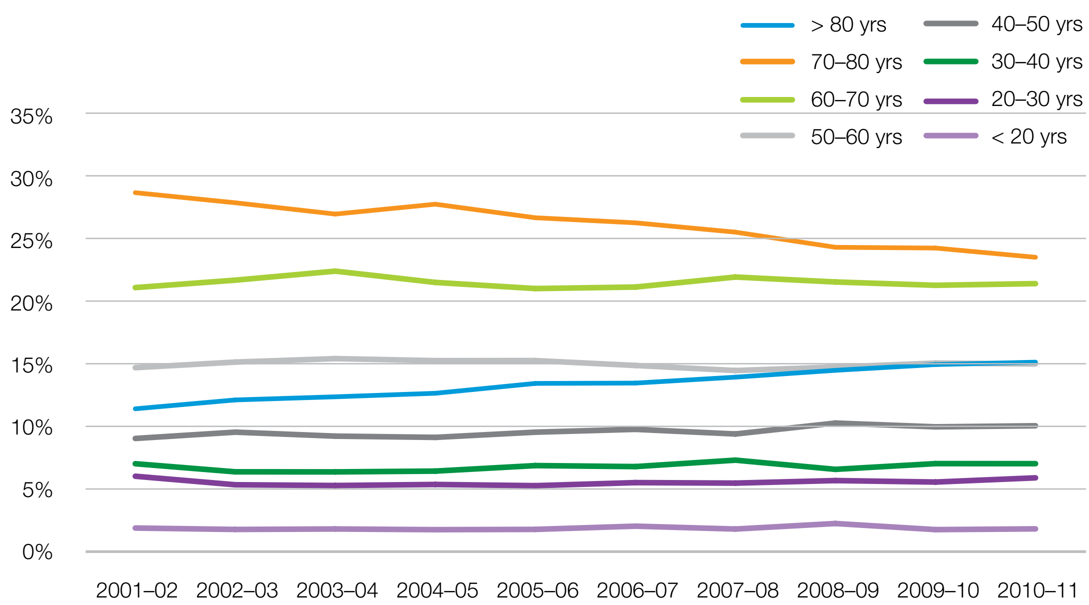
Utilisation of ICU services is also described in terms of patient characteristics such as age, acuity of illness, diagnosis and whether they are an elective or emergency admission. A further measure is length of stay in ICU, which may be influenced by the above patient factors as well as clinical practice and system factors.

Patient age

There are some interesting trends in the age profile of patients admitted to public intensive care services:

- The largest proportion of ICU admissions is in the 70–80 age group, although this proportion has fallen over the past 10 years from 29% to 24% (Figure 11). At the same time this age group has remained unchanged as a proportion of the overall population (Figure 12).
- The proportion of ICU patients in the over-80 age group has seen a modest increase, slightly more than the increase in the population.
- While the proportion of 60–69 year olds has increased in the population, their representation among ICU admissions has remained constant.
- The median age of patients admitted to ICU is slightly younger in tertiary ICUs, 64.0 (interquartile range (IQR) 49.8–74.2) compared with metropolitan services, 66.0 (IQR 51.4–77.0) and regional/rural services, 66.7 (IQR 50.0–77.2).
- The median age has decreased slightly in regional/rural services over the 10-year period from 69.9 (IQR 55.4–77.5) to 66.7 (IQR 50.0–77.2) but not in the other categories.

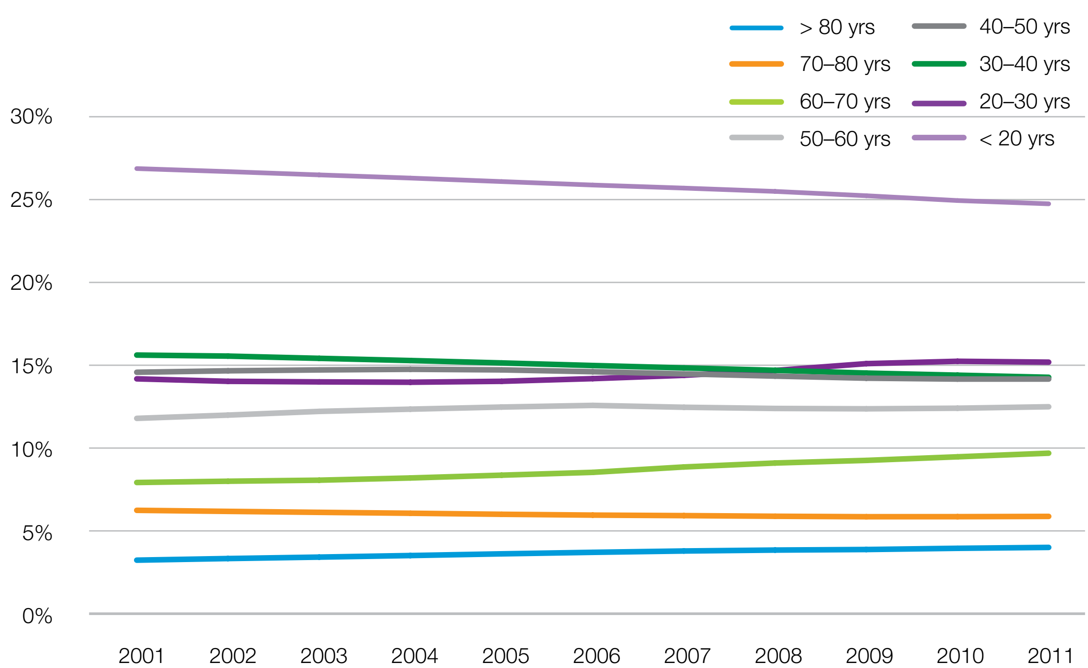
Figure 11: Percentage of adult admissions to ICU in Victoria by age group, 2001–02 to 2010–11



Source: APD

Note: Not all hospitals report to APD every year.

Figure 12: Percentage of Victorian population, by age group, 2001 to 2011 (all ages)



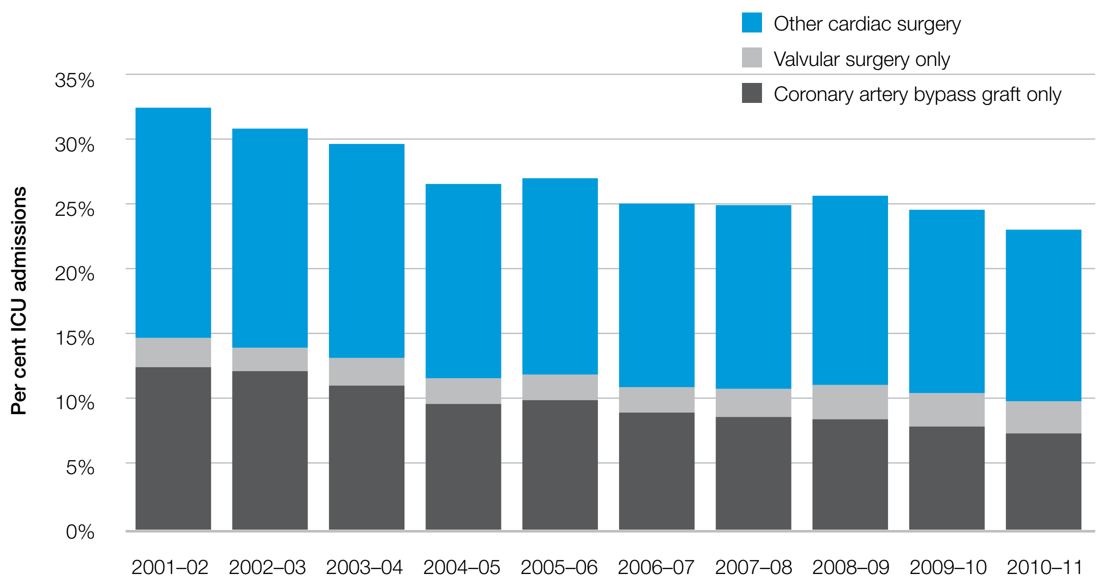
Source: Australian Bureau of Statistics

Admission diagnosis

Trends in admissions relating to diagnostic subgroups are largely attributable to a number of significant changes in clinical practice:

- Cardiac surgery is the most common reason for admission to intensive care, accounting for over a third of admissions in 2001–02 and 26% in 2010–11 (Figure 13). The decline reflects a shift to percutaneous interventions for a range of cardiac procedures, including coronary artery bypass grafts. This change is particularly evident in tertiary centres where much of the major cardiac surgery is conducted. Admissions to ICU relating to surgery for coronary artery grafts declined from 24% in 2001–02 to 14% in 2010–11 in these centres (Table 3a). The changes also mean that these procedures are now being performed at metropolitan hospitals.
- Other common surgical diagnoses over the 10-year period include surgery for gastrointestinal neoplasm (4.3%) and orthopaedic surgery (2.4%).
- Top medical diagnoses for admission to ICU over the past 10 years include
  - drug overdose (3.6%)
  - cardiac arrest (3.1%)
  - bacterial pneumonia (2.6%)
  - sepsis with shock (2.5%)
  - sepsis (2.4%)
  - COPD (2.3%).
- Casemix variations are evident between tertiary, metropolitan and regional/rural intensive care services, which reflect the differences in service capability as well as changes in capability over time (Table 3).

Figure 13: Cardiac surgery admissions in ICU as proportion of total ICU admissions, 2001–02 to 2010–11



Source: VAED

Table 3: Top five diagnoses on ICU admission, 2001–02 compared with 2010–11, by hospital classification

a) Tertiary

Diagnosis 2001–02	Number (%) n = 6,606		Diagnosis 2010–11	Number (%) n = 10,704
Coronary artery bypass graft	1,615 (24.4)	1	Coronary artery bypass graft	1,504 (14.1)
Valvular heart surgery	424 (6.4)	2	Valvular heart surgery	584 (5.5)
Surgery for gastrointestinal neoplasm	217 (3.3)	3	Cardiac arrest	399 (3.7)
Surgery for other respiratory diseases	213 (3.2)	4	Sepsis with shock, other than urinary	399 (3.7)
Surgery for head trauma and/or multiple trauma	193 (2.9)	5	Coronary artery bypass graft with valve repair/ replacement	355 (5.3)

b) Metropolitan

Diagnosis 2001–02	Number (%) n = 2,106		Diagnosis 2010–11	Number (%) n = 4,835
Drug overdose	181 (8.6)	1	Surgery for gastrointestinal neoplasm	376 (7.8)
Cardiac arrest	121 (5.7)	2	Drug overdose	294 (6.1)
COPD	101 (4.8)	3	COPD	228 (4.7)
Bacterial pneumonia	100 (4.7)	4	Bacterial pneumonia	224 (4.6)
Surgery for gastrointestinal perforation or rupture	92 (4.4)	5	Sepsis, other than urinary	219 (4.5)

c) Regional/rural

Diagnosis 2001–02	Number (%) n = 2,061		Diagnosis 2010–11	Number (%) n = 4,985
Acute myocardial infarction	201 (9.7)	1	Orthopaedic surgery	315 (6.3)
Rhythm disturbance	191 (9.3)	2	COPD	244 (4.9)
Orthopaedic surgery	147 (7.1)	3	Drug overdose	238 (4.8)
Other cardiovascular disease	146 (7.1)	4	Surgery for gastrointestinal neoplasm	236 (4.7)
Surgery for gastrointestinal neoplasm	92 (4.5)	5	Bacterial pneumonia	216 (4.3)

Source: APD

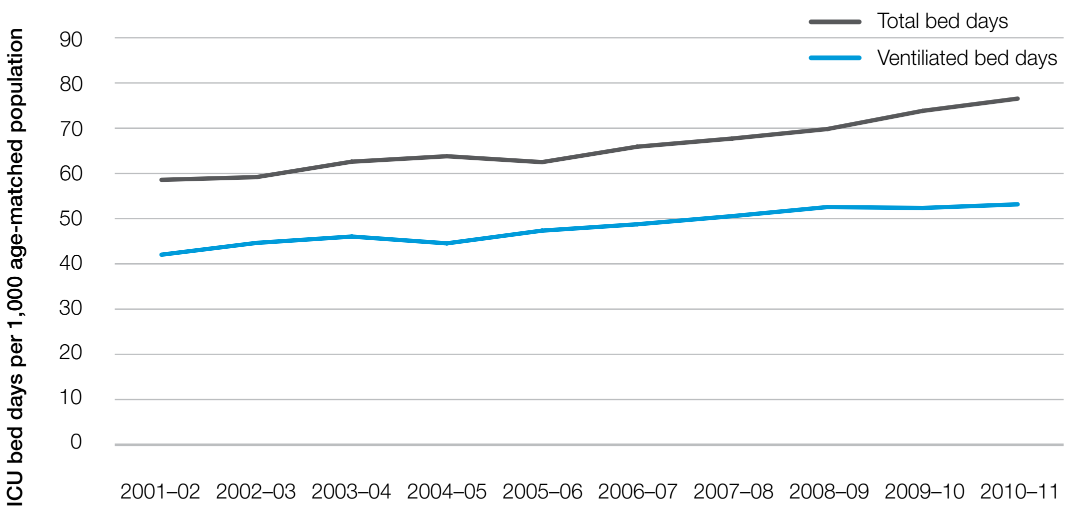
Note: Not all hospitals contribute to APD every year.

Patient acuity – admissions requiring mechanical ventilation

Mechanical ventilation is a therapy specific to ICUs and identifies a patient with greater severity of illness and thus greater risk of mortality and longer ICU length of stay.

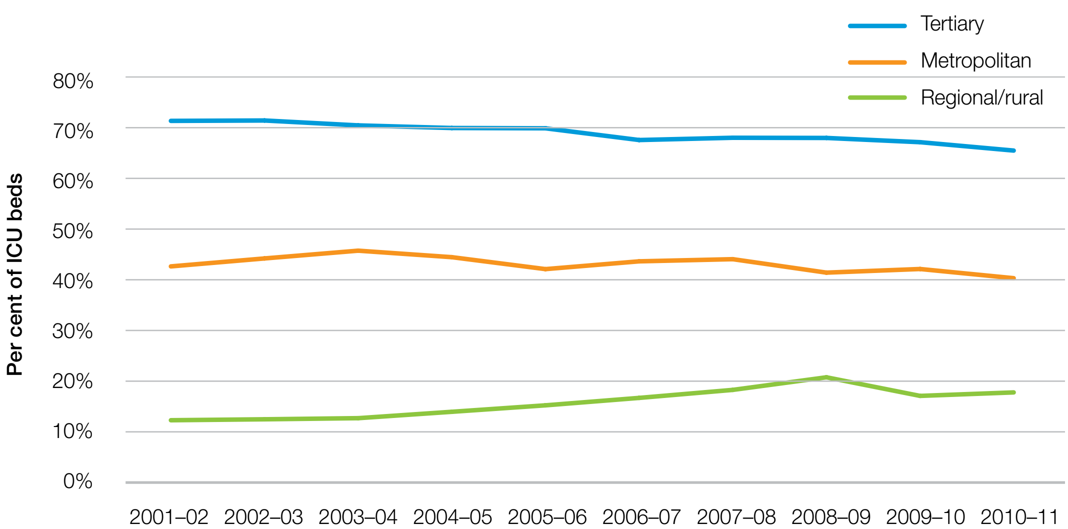
- A high proportion of ICU patients requires mechanical ventilation – 48% overall in 2001–02 and 45% in 2010–11 (Source VAED).
- The rate of mechanical ventilation is higher in tertiary hospitals compared with metropolitan and rural units, reflecting the higher acuity of patients admitted to tertiary hospital ICUs (Figure 15).
- Figure 15 shows a reducing trend in mechanical ventilation in tertiary and metropolitan hospitals, which may reflect a trend towards the use of non-invasive ventilation.

Figure 14: Total ICU bed days and ventilated bed days (per 1,000 age-matched population)



Source: VAED

Figure 15: Percentage of ICU beds occupied by patients receiving mechanical ventilation reported to the VAED, by hospital classification, 2001–02 to 2010–11



Source: VAED

Source of admission

ICUs interact with all areas of the hospital; patients are admitted to ICU from theatre and recovery, from the emergency department and the wards (Figure 16). They also interact with external services via transfers to and from other hospitals and other ICUs, and via ‘defined transfers’, which is a system that authorises ARV to nominate a hospital to receive a patient even when all critical care beds in the state are apparently filled (see page 13).

Admissions are considered elective if an ICU bed has been booked prior to surgery or a procedure. For example, the majority of patients undergoing coronary bypass surgery would be considered elective. Patients admitted to ICU from the emergency department, hospital wards and other hospitals are classified as emergency admissions, as are some patients with intraoperative complications.

Following are the main trends observed over the 10-year period for adult ICU admissions:

- The majority of admissions are from operating theatre or recovery, accounting for 48% of admissions in 2001–02 and 43% in 2010–11 (Figure 17).
- The decline in admissions from operating theatre/recovery is almost entirely attributable to tertiary services, where admissions from this source have fallen by more than 10% (Figure 18). This trend reflects changes in practice towards minimally invasive techniques such as percutaneous coronary artery revascularisation.
- This trend is also reflected in a declining proportion of elective surgery admissions in both tertiary and regional/rural services; however, metropolitan services have seen an increase in the proportion of elective surgery admissions. Tertiary hospitals maintain the highest level of elective admissions, reflecting the more complex elective care provided by these services (Figure 19).

Figure 16: Critical care services – source of admissions and interactions

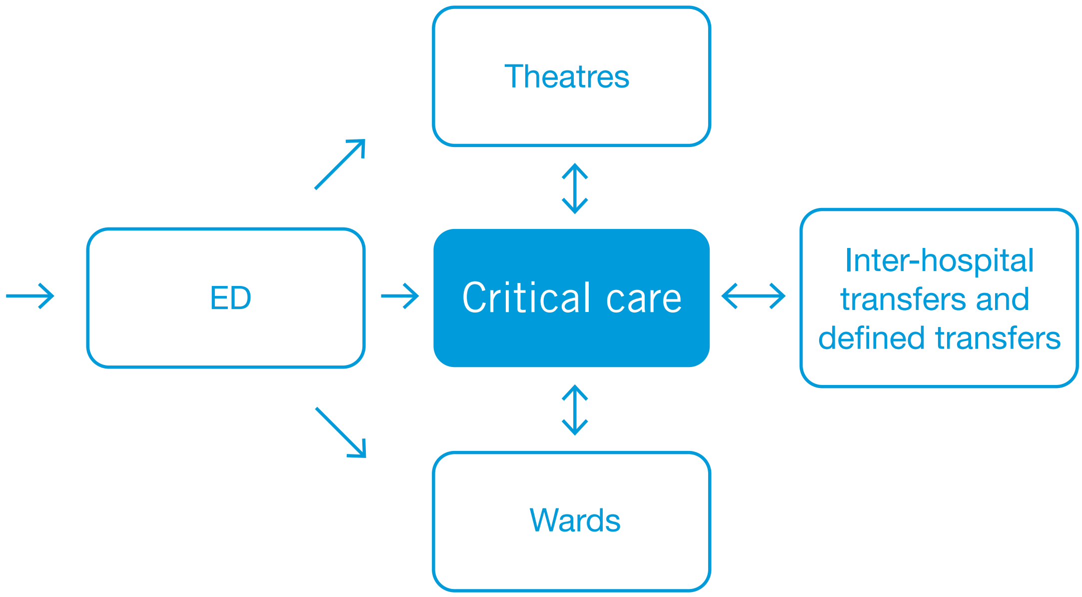
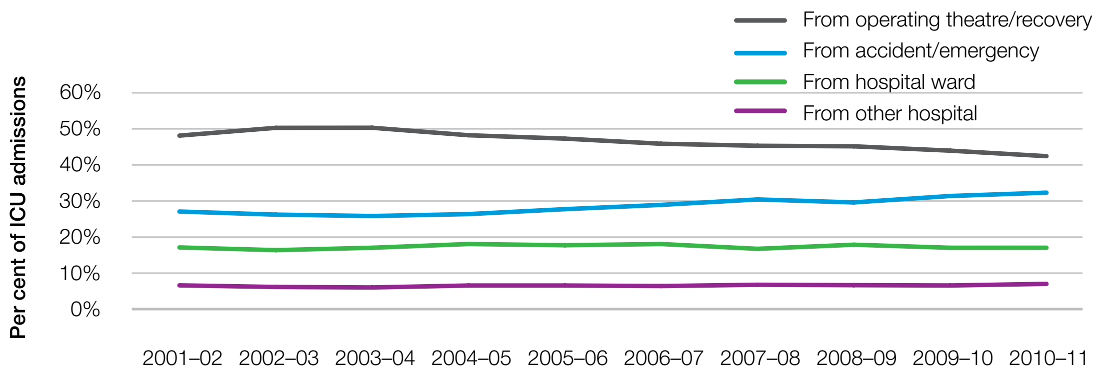
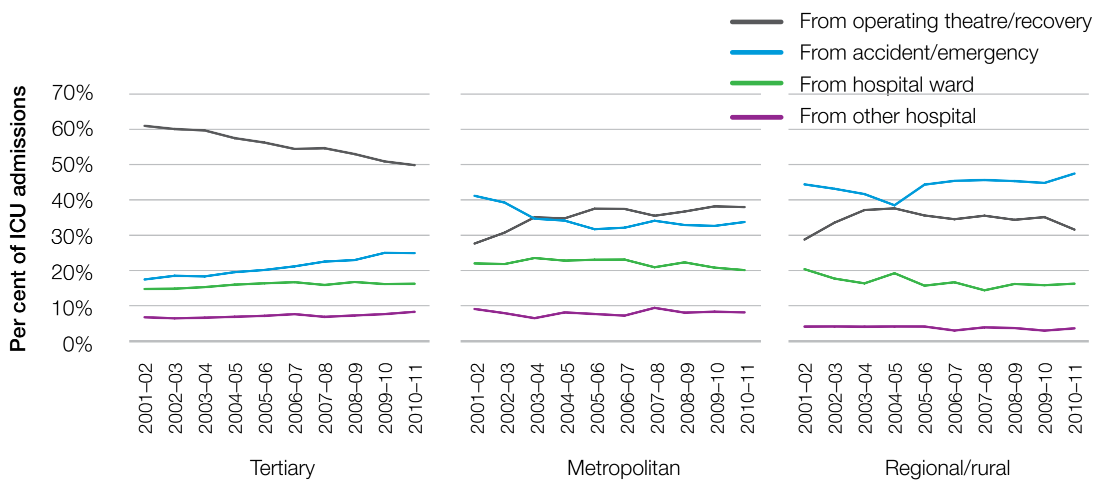


Figure 17: Percentage of adult admissions to ICU, by admission source, 2001–02 to 2010–11



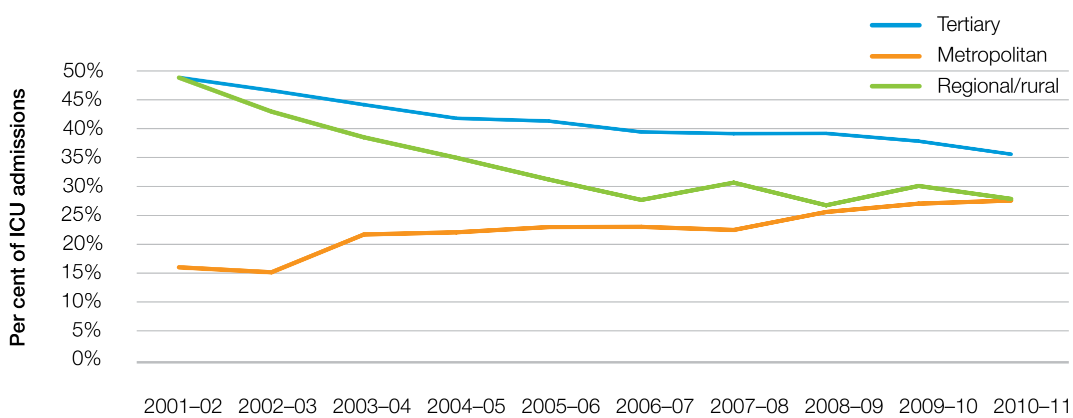
Source: APD

Figure 18: Percentage of adult admissions to ICU, by admission source and by hospital classification, 2001–02 to 2010–11



Source: APD

Figure 19: Percentage of adult admissions to ICU relating to elective surgical procedures, by hospital category, 2001–02 to 2010–11



Source: APD

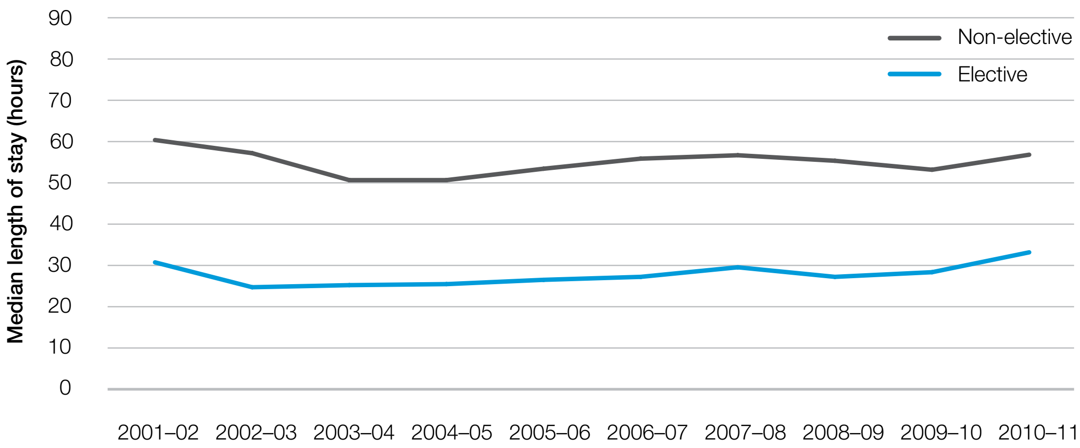
Note: Not all hospitals contribute to APD every year.

Length of stay

Length of stay in intensive care is measured in hours and is affected by a wide range of variables including the severity of illness and changes in clinical management. It can also be affected by system-related factors such as patient flow.

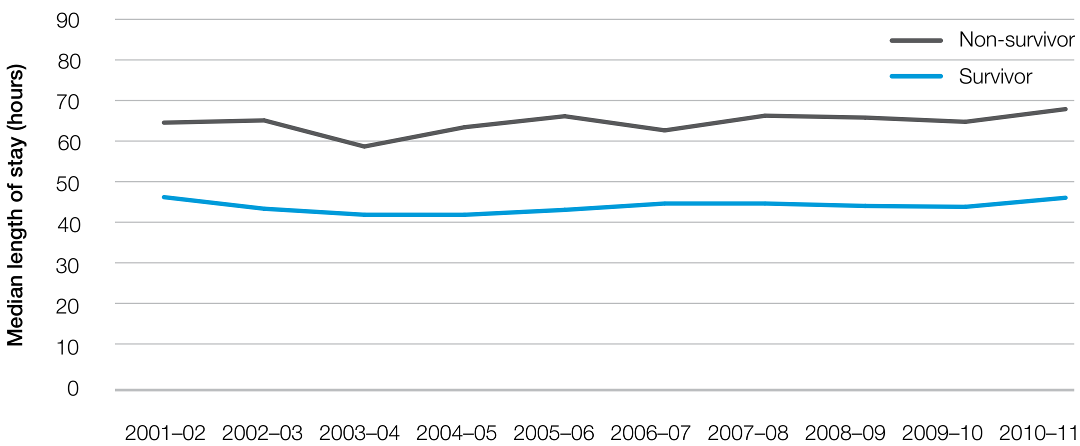
- Length of stay is longer for higher acuity patients including emergency admissions. Emergency patients stay in ICU approximately twice as long as elective patients (Figure 20). Certain patient groups, such as those with burns, spinal injuries and pancreatitis, tend to require particularly long stays in ICU.
- Similarly, non-survivors, who would be assumed to have more severe illness, have longer lengths of stay compared with survivors (Figure 21).
- Length of stay is slightly higher among patients admitted to metropolitan ICUs compared with tertiary and regional/rural centres, although the three categories have converged in the past three years covered by this report (Figure 22).
- Length of stay for surgical patients has increased, possibly reflecting an increase in complex surgical patients (Table 4 and Figure 23).
- The increase in length of stay for patients with cardiac arrest is likely due to the widespread uptake of therapeutic hypothermia to treat the brain injury associated with this condition. The reduction in length of stay for patients with COPD is likely due to increased use of non-invasive ventilation. The similar reduction for infective conditions is probably due to early recognition and treatment of sepsis. Reasons for the increased length of ICU stay for patients undergoing heart and gastrointestinal surgery are less clear but may be due to smaller numbers of 'routine' patients who have few or no comorbidities in recent years.
- Reductions in length of stay for a number of common medical diagnoses also reflect recent changes in clinical practice including:
  - use of non-invasive ventilation in patients with respiratory conditions such as COPD
  - focus on early identification of the deteriorating patient and early instigation of antibiotics (such as for pneumonia)
  - use of protocols of care to support consistent and improved approaches to identifying and managing sepsis.

Figure 20: Median length of stay (hours) for all ICUs, comparing elective and non-elective admissions, 2001–02 to 2010–11



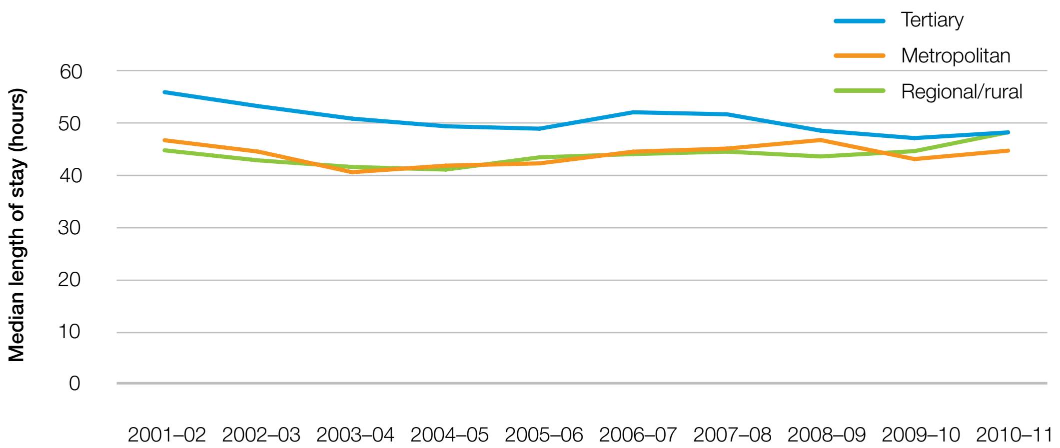
Source: VAED

Figure 21: Median length of stay (hours) for all ICUs, comparing survivors and non-survivors, 2001–02 to 2010–11



Source: VAED

Figure 22: Median length of stay (hours) in ICU, by hospital classification, 2001–02 to 2010–11



Source: VAED

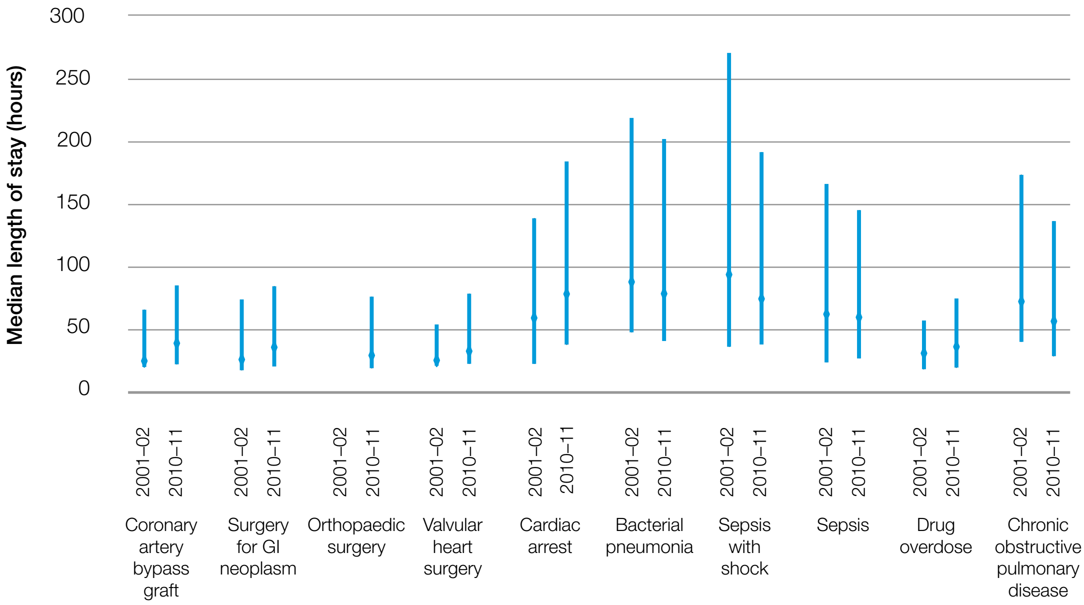
Table 4:Median length of stay (hours) for all ICUs, comparing top 10 admission diagnoses, 2001–02 and 2010–11

Median length of stay, hours (IQR) 2001–02	APACHE III-J diagnosis	Median length of stay, hours (IQR) 2010–11
	Surgical	
25.2 (20.4–61.3)	Coronary artery bypass graft	39.3 (22.5–68.7)
25.7 (21.3–50.0)	Valvular heart surgery	33.0 (22.9–68.8)
26.3 (17.8–65.8)	Surgery for gastrointestinal neoplasm	36.1 (20.8–69.5)
No data	Orthopaedic surgery	29.6 (19.4–66.3)
	Medical	
31.3 (18.6–44.7)	Drug overdose	36.5 (19.9–58.5)
59.5 (22.8–102.4)	Cardiac arrest	78.6 (38.3–144.1)
72.6 (40.4–141.5)	COPD	56.9 (29.0–109.0)
94.1 (36.5–213.5)	Sepsis with shock	74.8 (38.3–155.4)
62.5 (24.0–128.0)	Sepsis	60.0 (27.2–112.8)
88.3 (48.1–179.0)	Bacterial pneumonia	78.9 (41.1–164.6)

Source APD

Note: Not all hospitals contribute to APD every year.

Figure 23: Trends in length of stay in ICU (hours) for top 10 admission diagnoses, all hospitals, 2001–02 and 2010–11



Source: APD

Note: Not all hospitals contribute to APD every year.

The intensive care workforce

The critical care workforce is central to achieving positive outcomes for critically ill patients. These patients require around the clock monitoring and usually require complex care. This includes input from a diverse multidisciplinary team consisting of specialist medical, nursing, physiotherapy, pharmacy, dietetic, speech therapy, social work, pastoral and biomedical staff. More than simply treating a physical illness, these staff are required to provide psychological and emotional support for patients and their families and friends.

The ICU workforce includes the expansion of critical care outreach services through rapid response teams and liaison roles, thus increasing the demand on the resources and skills required to deliver these services.

Workforce capacity is closely monitored and managed by each health service. Each year the ANZICS CCR registry survey provides an overview of staff resources. Participating units report characteristics of the senior medical workforce (Table 5) and the critical care nursing workforce (Table 6).

In the regional/rural ICUs there is a significantly lower proportion of specialist intensivists employed – approximately half that found in tertiary hospitals. To a large degreee this reflects the acuity of patients in rural and regional units. To ensure patients receive appropriate care, specialist roles are often shared between anaesthesia, emergency, internal medicine and ICU.

Growth in the number of specialist intensivists (measured as full-time equivalent or 'FTE') has been highest in the tertiary centres where most of the increase in service demand has been observed.

In the 10-year period from 2001–02 to 2010–11, the nursing workforce in ICUs has developed both in numbers and in level of expertise to meet the growing capacity of the service (Table 6):

- 60% increase in number of registered nurses rostered to ICU
- 42% increase in registered nurse FTE
- 49% increase in the number of registered nurses with a critical care qualification
- 45% reduction in FTE vacancies.

A drop in the proportion of registered nurses with critical care qualifications was observed in 2009–10, which may coincide with a change in the focus for funding nursing courses within health services. Since that time many units have begun offering their own bridging courses that are recognised by the teaching institutions, and recovery is starting to become evident.

Table 5:Self-reported characteristics of the senior medical workforce in Victorian ICUs, 2006–07 to 2010–11

All levels	2006–07	2007–08	2008–09	2009–10	2010–11
Number of units	22	22	Data not available	23	21
Total specialist FTE – intensivists and non-intensivists	73.6	79.4		82.6	87.6
Intensivist-only FTE	57.6	67.6		71.2	77.7
Proportion of specialist FTE that are intensivists	78.3%	85.1%		86.2%	88.6%
Total available beds	229	229		240	240
Tertiary					
Number of units	6	6		6	6
Total specialist FTE – intensivists and non-intensivists	35.3	39.0		41.5	48.1
Intensivist-only FTE	35.0	38.7		41.5	47.6
Proportion of specialist FTE that are intensivists	99.2%	99.2%		100.0%	99.0%
Total available beds	109	111		122	125
Metropolitan					
Number of units	7	7		7	6
Total specialist FTE – intensivists and non-intensivists	19.9	23.5		22.4	21.9
Intensivist-only FTE	18.3	22.2		21.7	21.4
Proportion of specialist FTE that are intensivists	91.7%	94.3%		96.9%	97.7%
Total available beds	64	65		68	61
Regional/rural					
Number of units	9	9		10	9
Total specialist FTE – intensivists and non-intensivists	18.3	16.9		18.7	17.6
Intensivist-only FTE	4.3	6.7		8.0	8.7
Proportion of specialist FTE that are intensivists	23.5%	39.7%		42.9%	49.1%
Total available beds	56	53		50	54

Source: CCR registry

Note: Not all hospitals report to the CCR registry every year. Complete CCR data was not collected for 2008–09.

Does not include sessional or casual staff.

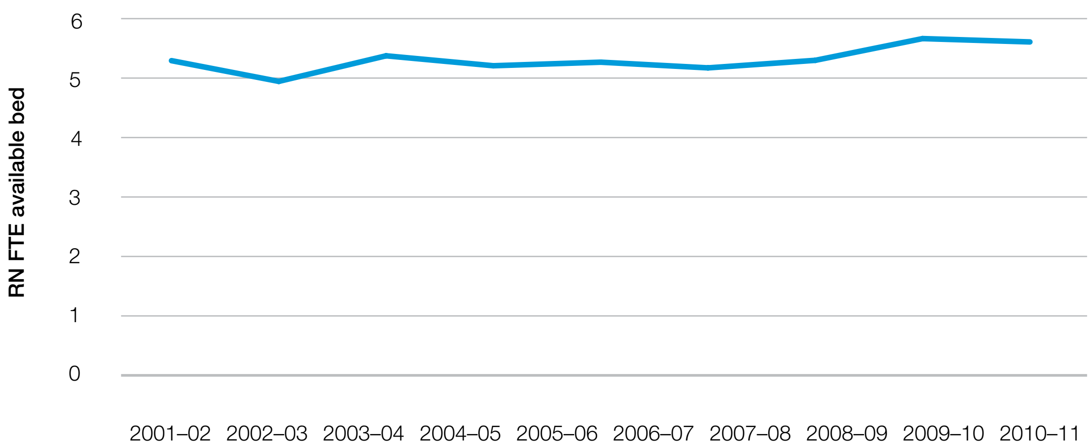
Table 6:Self-reported characteristics of the nursing workforce in Victorian ICUs, 2001–02 to 2010 –11

Nursing profile	2001 –02	2002 –03	2003 –04	2004 –05	2005 –06	2006 –07	2007 –08	2008 –09	2009 –10	2010 –11
Number of contributing units	21	22	21	21	22	22	22	Data not available	23	21
Available beds	179	214	196	199	213	229	229		240	240
Registered nurse (RN) FTE	949.8	1,060.7	1,056.1	1,038.9	1,124.8	1,187.3	1,216.4		1,362.8	1,349.3
Number of RN (permanent/rostered)	1,301	1,500	1,334	1,440	1,609	1,682	1,764		2,152	2,080
RNs with critical care qualifications	982	1,159	1,001	1,099	1,176	1,249	1,352		1,405	1,465
% RNs with critical care qualification	75.5%	77.3%	75.0%	76.3%	73.1%	74.3%	76.6%		65.3%	70.4%
RN FTE per available bed	5.3	5.0	5.4	5.2	5.3	5.2	5.3		5.7	5.6
RN FTE vacancies	106.2	59.0	60.2	85.1	123.0	114.0	145.5		68.8	58.8
Vacancies as proportion of FTE	11.2%	5.6%	5.7%	8.2%	10.9%	9.6%	12.0%		5.1%	4.4%

Source: CCR registry

Note: Not all hospitals report to the CCR registry every year. Complete CCR data was not collected for 2008–09.
Does not include bank or casual staff.

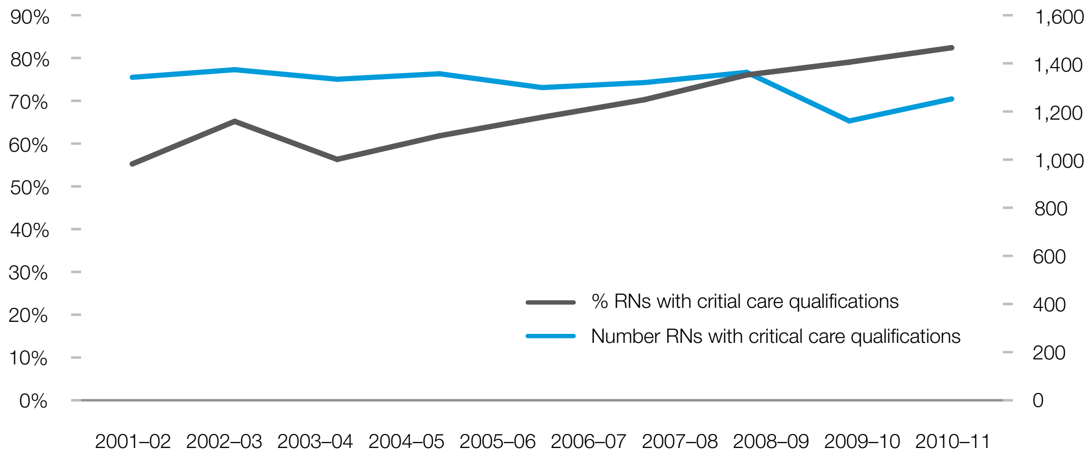
Figure 24: Registered nurses FTE per available bed, 2001–02 to 2010–11



Source: CCR registry

Note: Not all hospitals report to the CCR registry every year. Complete CCR data was not collected for 2008–09.

Figure 25: Registered nurses with critical care qualifications, number with qualifications and percentage of with a qualification, 2001–02 to 2010–11



Source: CCR registry
Note: Not all hospitals report to the CCR registry every year
Complete CCR data was not collected for 2008–09

Moira's story

A forty 40-year-old woman (married with young teenage twins) in the country presented to a regional hospital feeling unwell and was found to be in septic shock.

She was intubated and placed on inotropes then transferred to a metropolitan ICU. She grew pneumococcus in her blood and was found to have had a splenectomy following a car accident when aged 15 but had had no prophylaxis or vaccines.

She required four days of ventilation and seven days of haemofiltration. She had severe gangrene of the fingers and feet but otherwise did well, being discharged from the ICU after seven days. She presented issues for the ward, especially in relation to monitoring her blood pressure and oxygen saturation with peripheral gangrene.

The liaison team visited her multiple times during the ensuing days to support the ward staff and to teach them about taking and interpreting observations. Sixteen days later the liaison nurses noted the patient had tachypnoea and hypoxia and was not safe to go to X-ray as planned. She was readmitted to ICU for management of hypoxia. She only stayed two days but left ICU much improved.

Trends in intensive care outcomes

Return to health and independence are desirable outcomes after serious illness. Given the role of ICUs in providing life-saving and life-sustaining care, mortality is a key outcome measure and is a feature of service monitoring through the VICDRC annual reporting process (page 11).

Mortality is analysed in two ways:

- In-hospital mortality (percentage of admissions)
- Standardised mortality ratio.

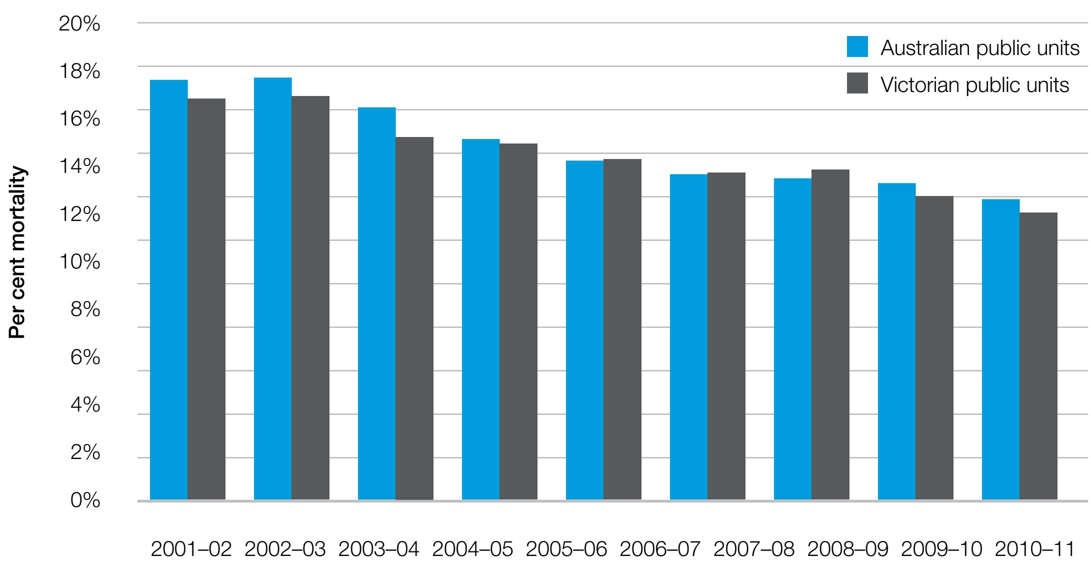
In-hospital mortality is the raw numerical data expressed as the rate (%) of patient deaths for those admitted to intensive care over a given period. It is useful for comparing trends over time for a particular hospital or group of hospitals, or for the system overall.

The casemix and severity of illness of patients admitted to an individual ICU heavily influence the outcomes at that unit, making comparisons of raw mortality at different hospitals misleading. For example, a hospital that receives patients with greater severity of illness will be expected to have higher mortality. Risk-adjusted data allows a more accurate comparison between units and regions. Even risk-adjusted mortality results have limitations that must be considered when making comparisons.

In-hospital mortality for patients admitted to intensive care

Over the 10 years from 2001–02 to 2010–11 there has been a gradual but significant decline in hospital mortality for patients admitted to intensive care, with trends in Victoria being similar to those observed in Australian ICUs overall (Figure 26).

Figure 26: In-hospital mortality for patients admitted to Victorian and Australian public ICUs as a percentage of ICU admissions, 2001–02 to 2010–11



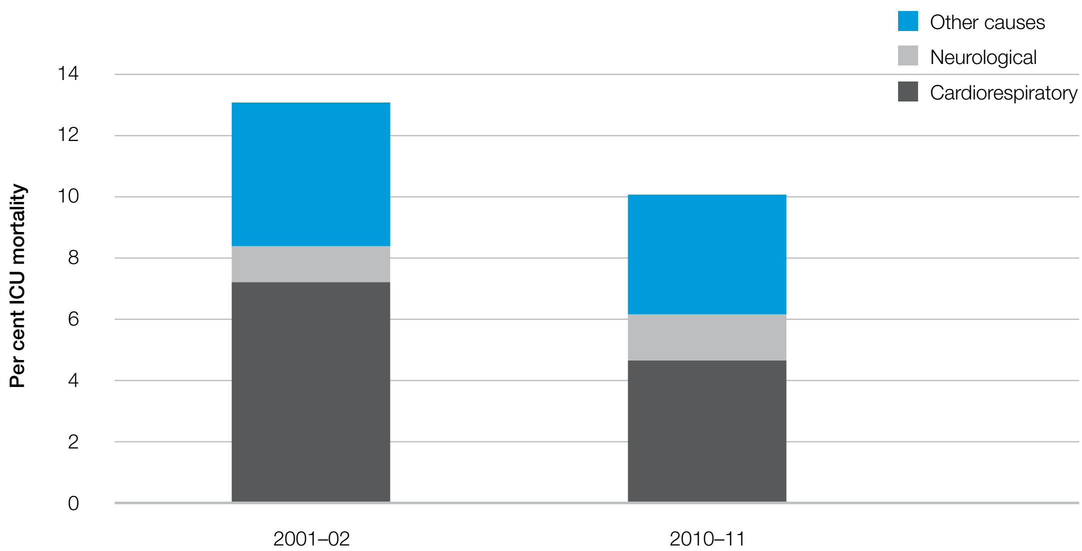
Source: APD

Note: Not all hospitals contribute to APD every year.

As mentioned above, casemix (the type of patient such as cardiac or respiratory) and acuity (the severity of illness) will significantly affect mortality outcomes for individual ICUs. The most capable, best equipped and staffed ICU will receive the most complex and sickest patients. However, other notable factors relating to mortality in the ICU that need to be considered for the period of this review include the following.

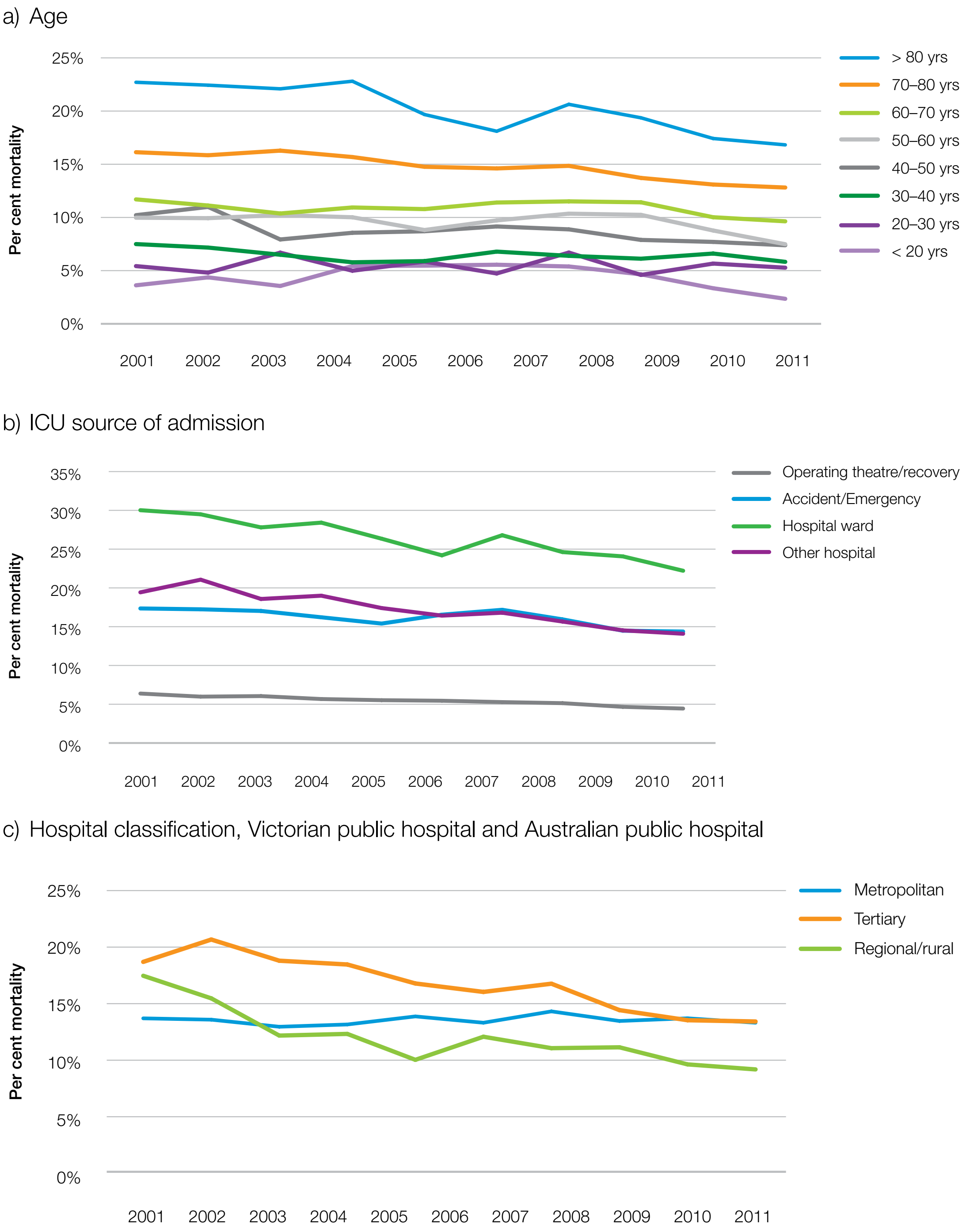
- Cause of mortality has changed over time. In 2001, deaths in the ICU were most common following cardiorespiratory causes of admission, such as cardiac arrest and pneumonia. Advances in intensive care treatments over the decade have led to these diagnoses having the greatest reduction in mortality (Figure 27).
- Hospital mortality increases with age, with those aged over 80 years experiencing the highest level of in-hospital mortality. This group has, however, seen the greatest decline in mortality over the 10-year period (Figure 28a). Age itself is not a risk factor but is associated with a higher likelihood of chronic illness and limited physiological reserve to survive major illness. The majority of patients aged over 80 years admitted to ICU survive (85%) and return home.
- Mortality varies with the source of admission, being greater for patients admitted to intensive care from inpatient wards, emergency departments and other hospitals. This is because these patients are usually emergency admissions and have a greater severity of illness. Mortality is lowest among those admitted to intensive care from operating theatres, usually following elective major surgery (Figure 28b).
- Mortality is higher at tertiary and metropolitan hospitals that treat patients with more complex and severe illness. Over the 10 years, decline in raw mortality has been greatest for metropolitan and regional/rural ICUs (Figure 28c).

Figure 27: In-hospital mortality for patients admitted to intensive care according to cause of death, 2001–02 and 2010–11



Source: APD

Figure 28: In-hospital mortality for patients admitted to intensive care according to age, source of admission and hospital classification, 2001–02 to 2010–11



Source: APD

Note: Not all hospitals contribute to APD every year.

Risk-adjusted mortality (standardised mortality ratios)

What is the SMR and how is it interpreted?

The SMR is the number of observed deaths divided by the number of expected deaths, and can be expressed as a fraction (from zero to 1.0) or as a percentage (0 to 100%). It enables comparison between mortality rates by establishing the risk of death for a particular group of patients and by making adjustments for patient factors that are associated with increased risk of death but are outside the influence of the treating team and hospital.

An ICU where the number of predicted deaths equals the number of observed deaths would have an SMR of 1.0 (or 100%. A unit where fewer deaths are observed than predicted would have an SMR of less than 1.0 (or less than 100%), while a unit that had more deaths than predicted would have an SMR of more than 1.0 (or more than 100%). The 95% confidence interval of the SMR is used to quantify a reasonable (numerical) range within which the true SMR value is likely to lie. The greater the number of events (deaths, in this case) the narrower the confidence interval (range) will be and the more accurate the SMR. The fewer the number of deaths the less accurate is the SMR.

The SMR cannot be immediately interpreted as indicating inferior or superior care; however, it is used as a trigger to prompt further investigation. Many studies have shown that hospital casemix remains the greatest cause of variability.

How is the SMR calculated?

Expected deaths are calculated using models that predict the risk of death based on various patient variables collected during admission, and which adjust for patient factors as described above. These factors include age, severity of illness and diagnosis.

Two methods of calculating risk of death are used by the VICDRC for adult populations: the APACHE III-J and the COPE model.

- APACHE III was initially developed in the 1990s and is now in its tenth iteration (‘J’). It provides an international standard for assessing predicted risk of death. APACHE III-J severity of illness scores are based on data gathered on admission to ICU or available during the first 24 hours of ICU admission. Data elements include age, chronic health problems, physiological variables (temperature, pulse and blood pressure) and the results from routine blood tests. The APACHE III-J severity of illness score excludes a significant proportion of patients (burns, adolescents) so that comparative statistics don’t apply to all ICU admissions. The score has not been refined or recalibrated since 2003. Australian ICUs therefore consistently register APACHE III-J SMRs less than 1.0.

- The COPE model is based on the VAED administrative dataset and is an alternative model developed through a research project of the VICDRC and tested by the Northern Clinical Research Centre. The COPE model incorporates all intensive care patients, is locally derived, and is recalibrated each year. It is based on clinical and demographic data available from the VAED, but unlike APACHE it does not include physiological data. Hospital mortality is predicted from six admission variables: patient age, admission principal diagnosis, admission type, hospital peer group, cardiac surgical procedure and the use of mechanical ventilation. It has been found to be comparable to APACHE-III-J and a reliable indicator of hospital outcome. As a result of annual recalibration, the COPE-derived SMR values tend to be located around 1.0, whereas the APACHE III-J-derived SMR, which has not been recalibrated since 2003, produces values lower than 1.0. Each hospital result is in effect compared with the average for the entire state.
- A similar mortality scoring system, the Paediatric Index of Mortality (PIM2) score, is applied to paediatric ICU patients. This model is composed of physiological and laboratory values and provides a quantitative measurement to estimate the probability of ICU death in a paediatric population using a logistic regression model. Unlike APACHE, all components of PIM are obtained in the first face-to-face contact with the ICU or a specialist paediatric retrieval team. Like the COPE model the ANZPIC registry routinely recalibrates PIM2 based on Australian and New Zealand data to adjust for drifts in measurement over time.

Prediction models are only accurate in predicting group outcomes. They are not used to determine the outcome of an individual patient, nor as an arbiter of individual patient treatment. This remains the domain of the treating team in consultation with the patient and their family.

What are the trends in the SMR over the past 10 years?

Standardised mortality calculated using the APACHE III and COPE prediction models have both shown a reduction over the 10-year period, as illustrated in the caterpillar plots (Figure 29 to Figure 31). These plots are useful for comparing trends over time and show the 95% confidence intervals.

Reductions in standardised mortality were observed across all age groups over the 10-year period and is lower in younger age groups (Table 7).

The reduction among Victorian ICUs is similar to the reduction seen across Australia (Figure 29). This trend is also evident in the APACHE III SMR data for tertiary, metropolitan and regional/rural ICUs (Figure 30), although this is less evident for metropolitan ICUs according to the COPE data (Figure 31).

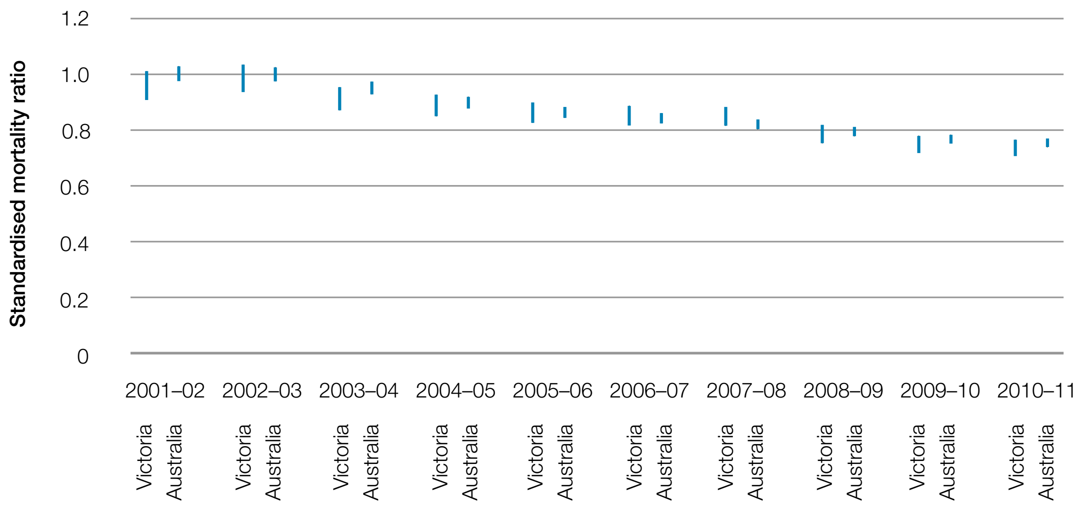
Table 7: APACHE III-J standardised mortality ratio, by age group, 2001–02 and 2010–11

APACHE III-J SMR 2001–02	Age group	APACHE III-J SMR 2010–11
0.52 (0.21–1.04)	< 20	0.41 (0.16–0.83)
0.77 (0.51–1.09)	20–30	0.66 (0.51–0.84)
0.76 (0.55–1.03)	30–40	0.65 (0.51–0.8)
0.98 (0.78–1.22)	40–50	0.63 (0.54–0.74)
1.0 (0.84–1.17)	50–60	0.68 (0.6–0.77)
0.92 (0.81–1.04)	60–70	0.74 (0.67–0.8)
0.97 (0.89–1.06)	70–80	0.73 (0.68–0.78)
1.05 (0.93–1.17)	> 80	0.85 (0.79–0.92)

Source: APD

Note: Not all hospitals contribute to APD every year.

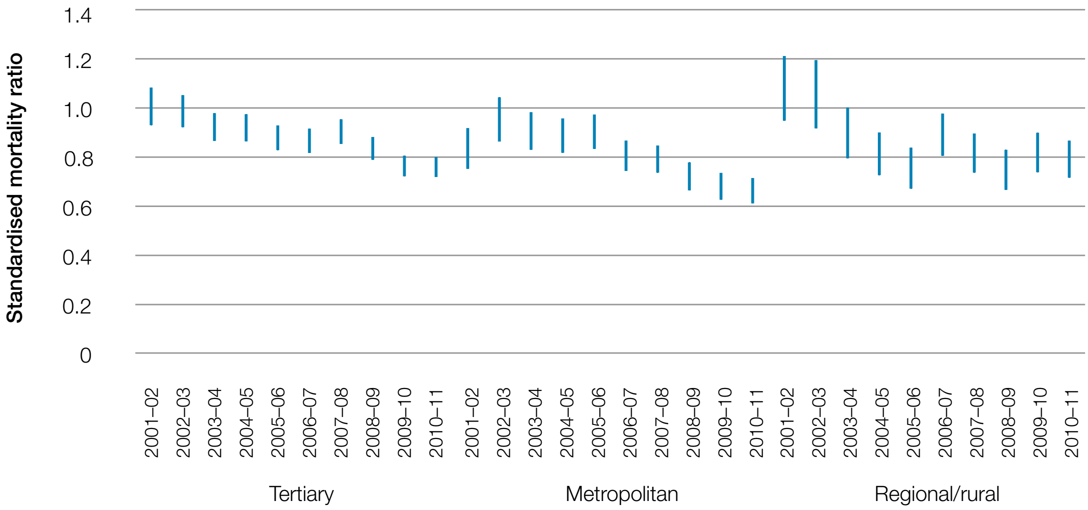
Figure 29: The 95% confidence interval for APACHE III-J standardised mortality ration for Victoria and Australia, 2001–02 to 2010–11



Source: APD

Note: Not all hospitals contribute to APD every year.

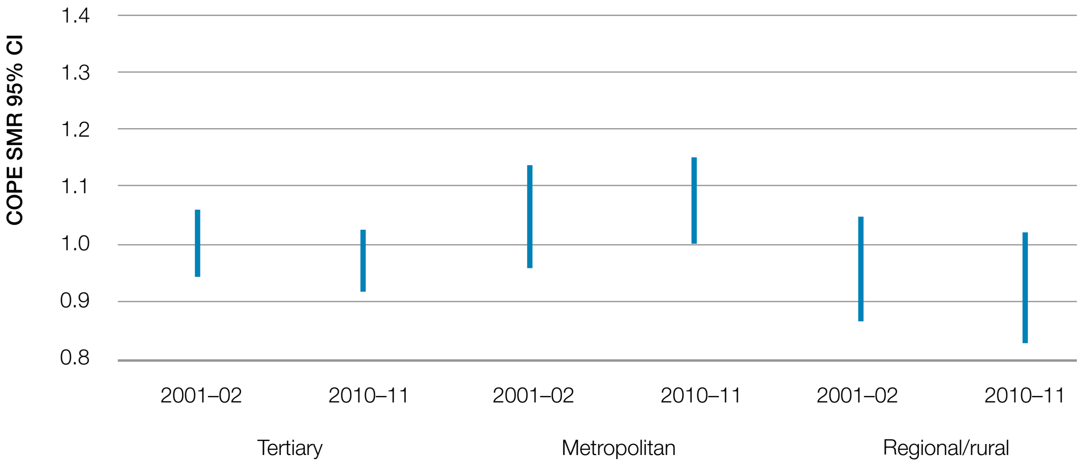
Figure 30: The 95% confidence interval for APACHE III-J standardised mortality ratio, by hospital classification, 2001–02 to 2010–11



Source: APD

Note: Not all hospitals contribute to APD every year.

Figure 31: The 95% confidence interval for COPE standardised mortality ratio, by hospital classification, 2001–02 and 2010–11



Source: VAED

Funnel plots

'Funnel plots' are a useful graphical aid for comparing SMRs for each ICU according to workload (throughput) over the same time period. The SMR for each hospital is plotted against the number of admissions, with 'control limits' forming a funnel around the target outcome, an SMR of one in the case of COPE funnels.

The plot identifies hospitals with higher (or lower) mortality than expected, as they will fall outside the (95% or 99%) control limits or confidence intervals. The technique helps monitor the performance of an ICU as compared with the rest of the group.

Figure 32 to Figure 34 show funnel plots for COPE-derived SMRs including all Victorian hospitals for the 10-year period (2001–11) (Figure 32), and for the one year periods 2001–02 (Figure 33) and 2010–11 (Figure 34).

Figure 32: COPE model funnel plot showing standardised mortality for all Victorian public hospitals, by hospital classification, 2001–02 to 2010–11

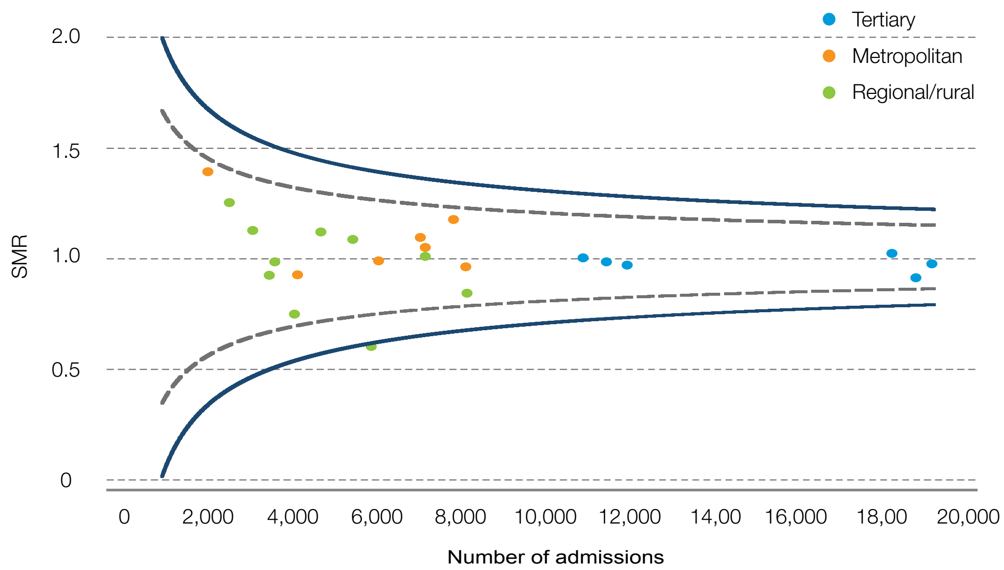


Figure 33: COPE model funnel plot showing standardised mortality for all Victorian public hospitals, by hospital classification, 2001–02

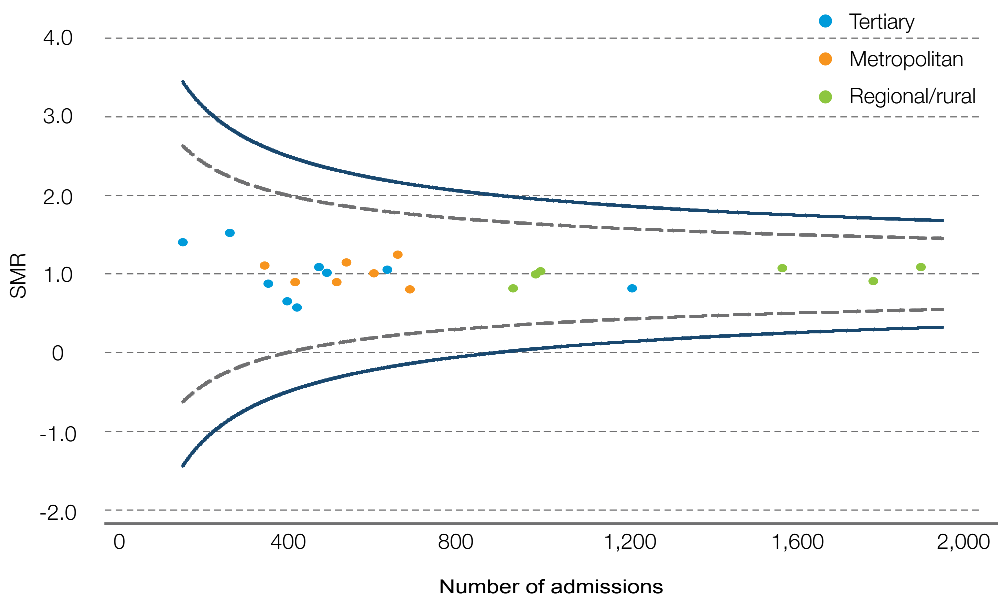
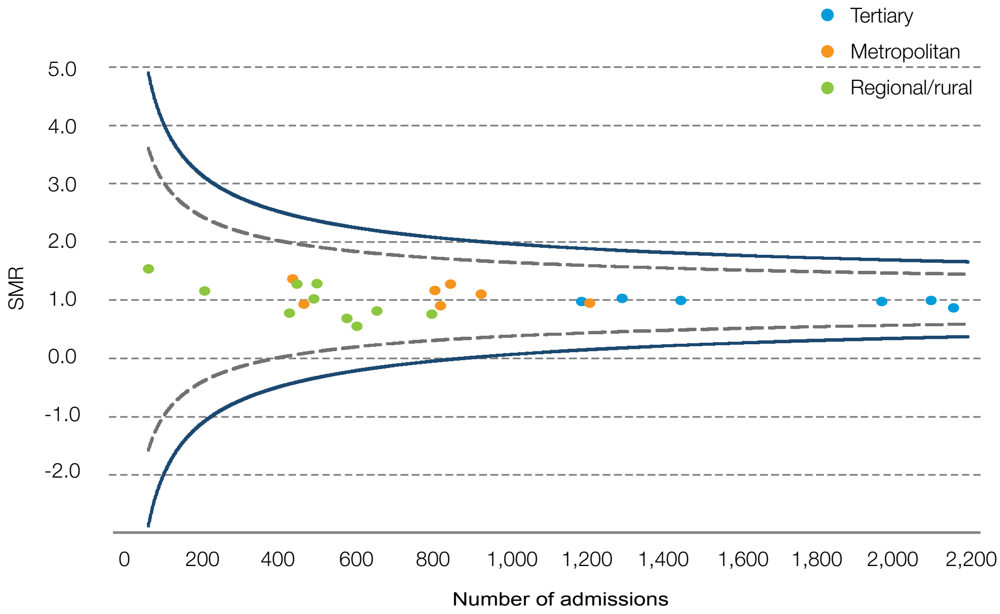


Figure 34: COPE model funnel plot showing standardised mortality for all Victorian public hospitals, by hospital classification, 2010–11



Paediatric intensive care

Severe and life-threatening illness in children is rare and the diseases responsible differ from those in the adult population. While capacity and expertise exists for metropolitan and rural ICUs to manage many children who need intubation for less than 24 hours, the delivery of high-quality intensive care to the majority of critically ill children (< 16 years) is made possible by the concentration of this small but important field in only two tertiary centres: The Royal Children's Hospital PICU and the paediatric section of the ICU at Monash Medical Centre. Over the 10 years from 2001–02 to 2010–11 more than 16,000 children have been treated in Victorian ICUs (Table 8). These figures include neonates who require intensive care for the treatment of congenital heart disease but not neonates looked after in the four Victorian tertiary neonatal units.

Table 8: Paediatric admissions to Victorian ICUs, 2001–02 to 2010–11

	Number of paediatric admissions (%)			
Hospital	The Royal Children's Hospital	Monash Medical Centre	Other public ICUs*	Total (n)
Paediatric admissions (% of Victorian paediatric admissions)	13,552 (81.3)	1,873 (11.2)	1,247 (7.5)	16,672

* excludes paediatric admissions to Monash Medical Centre.

Source: ANZPICR

The Royal Children's Hospital caters for the full range of paediatric medical and surgical subspecialties. It is also the Australian national centre for heart transplantation in children. Monash Medical Centre offers the major paediatric subspecialties including general surgery, cancer, respiratory, renal, neurology and neurosurgery.

Over the 10 years from 2001–02 to 2010–11, paediatric admissions in Victoria have increased from 1,412 to 2,006 per year. Most of this increase has been taken up by Monash Medical Centre, which developed its paediatric unit in response to the increased demand (Figure 35).

Respiratory conditions including bronchiolitis, asthma, pneumonia and respiratory failure are common reasons for children needing admission to intensive care. Together these conditions accounted for 15.4% of admissions in 2001–02 and 21.1% in 2010–11. Seizures accounted for 5.9% of admissions in 2001–02 and 6.4% in 2010–11.

Children requiring intensive care for cardiac surgery are looked after at The Royal Children's Hospital, where cardiac admissions accounted for 26.5% of ICU admissions in 2001–02 and 31.3% in 2010–11.

Figure 35: Paediatric admissions 2001–02 to 2010–11, The Royal Children's Hospital, Monash Medical Centre, other adult ICUs

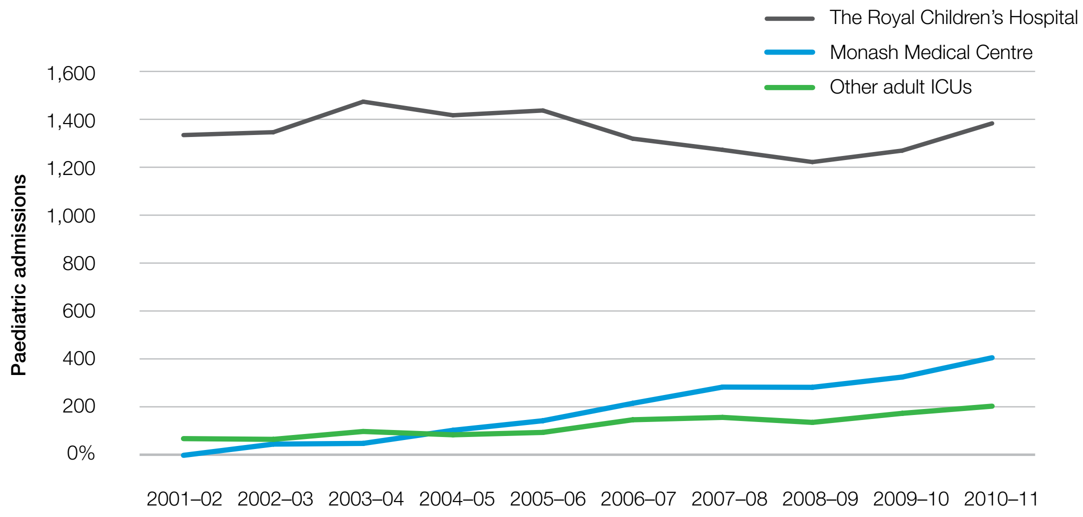


Figure 36: Trends in ventilation for paediatric admissions 2001–02 to 2010–11, The Royal Children's Hospital, Monash Medical Centre, other adult ICUs

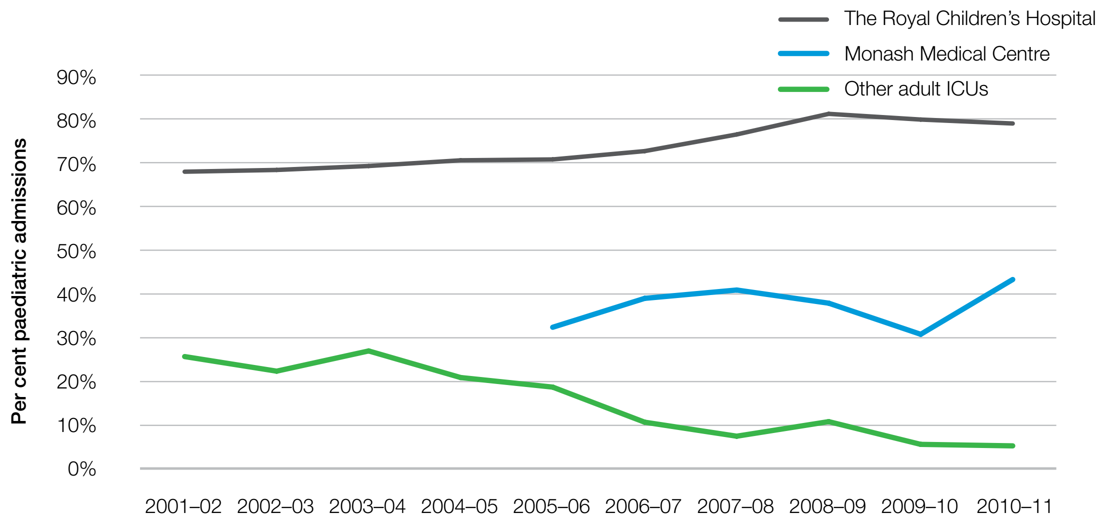
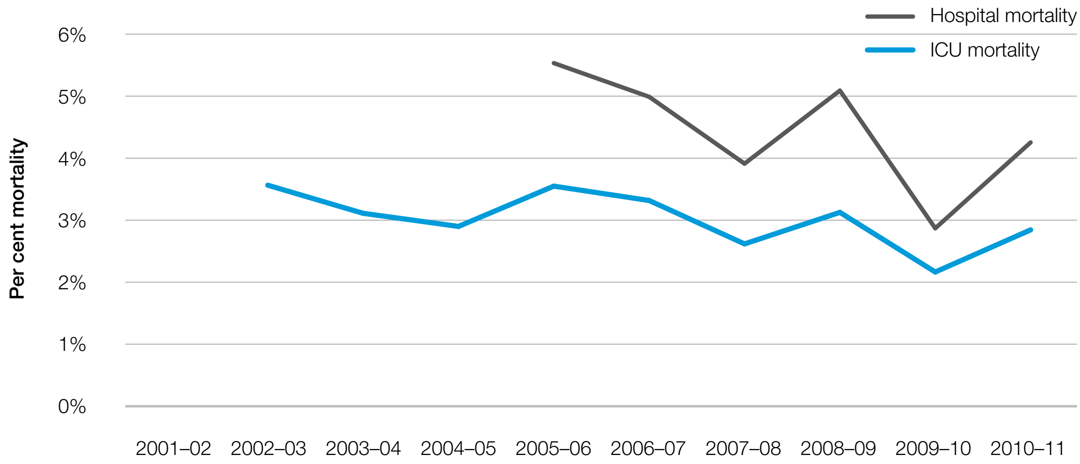


Figure 37: Mortality trends in Victorian paediatric ICUs 2001–02 to 2010–11, hospital mortality and ICU mortality



Source: ANZPICR

Note: The Royal Children's did not submit hospital mortality until 2005–06 and Monash Medical Centre did not submit ICU mortality data in 2001–02.

Paediatric Emergency Transport Service

Because paediatric intensive care is concentrated in the two tertiary centres in Melbourne, it is important that Victorian children living outside Melbourne have ready access to these centres. This access is provided by PETS operating out of The Royal Children's Hospital paediatric intensive care. PETS receives more than one thousand referrals a year, and provides a specialist doctor and specialist nurse for the emergency retrieval of children throughout Victoria, Tasmania and southern New South Wales to both The Royal Children's Hospital and Monash Medical Centre. The service works closely with NETS and the Perinatal Emergency Referral Service (PERS), under the leadership of the Paediatric Infant and Perinatal Emergency Referral (PIPER), with all three services accessible to any Victorian health professional though a single toll-free number (1300 137 650). PETS retrieves approximately 500 children a year. It also performs some transfers from other state capitals and, in cooperation with The Royal Children's Hospital Department of Cardiac Surgery, is the only paediatric intensive care retrieval service in Australia with an established ECMO transport capability.

During the past decade a number of technological and medical advances have improved the management of children requiring intensive care. For example, the use of high-flow oxygen has reduced the need for more invasive ventilation modes, and ECMO is now being used in a broader range of diseases including cardiac conditions, sepsis and pneumonia. The introduction of METs and PICU outreach teams has also improved patient care.

Shio’s story

A young infant presented to a metropolitan hospital with a short history of being unwell. The child was seen in the emergency department (ED) where she quickly deteriorated. ED specialists suspected a severe and overwhelming infection.

The ED clinician called 1300 137 650, the NETS/PETS/PERS emergency number, for advice and possible retrieval of the child to Monash PICU.

The ED clinician was immediately connected to The Royal Children’s intensive care specialist, who gave treatment advice, dispatched the PETS team, and determined that the child was at risk of needing extracorporeal life support. ECMO can be provided for children at The Royal Children’s Hospital but not at Monash.

The PETS team arrived at the referring hospital a short time later, and assisted the ED staff, before transporting the child to The Royal Children’s PICU. Intensive treatment continued during transport. When the child arrived at The Royal Children’s, a specialist team was waiting, and emergency surgery was performed within minutes to place the child on ECMO.

After several days of intensive treatment in the PICU, the child gradually improved and she was weaned off ECMO life support. She eventually made a full recovery.

Private hospital intensive care

Private hospitals have provided intensive care beds for many years. This activity expanded during the 1980s and 1990s with the establishment of ICUs capable of caring for patients following cardiac surgery. These beds are used to treat acutely ill patients within the private sector and to care for public patients in times of peak demand. Currently there are 14 private hospitals that provide intensive care services in Victoria, 11 located in metropolitan Melbourne and three located in regional/rural areas (Table 9).

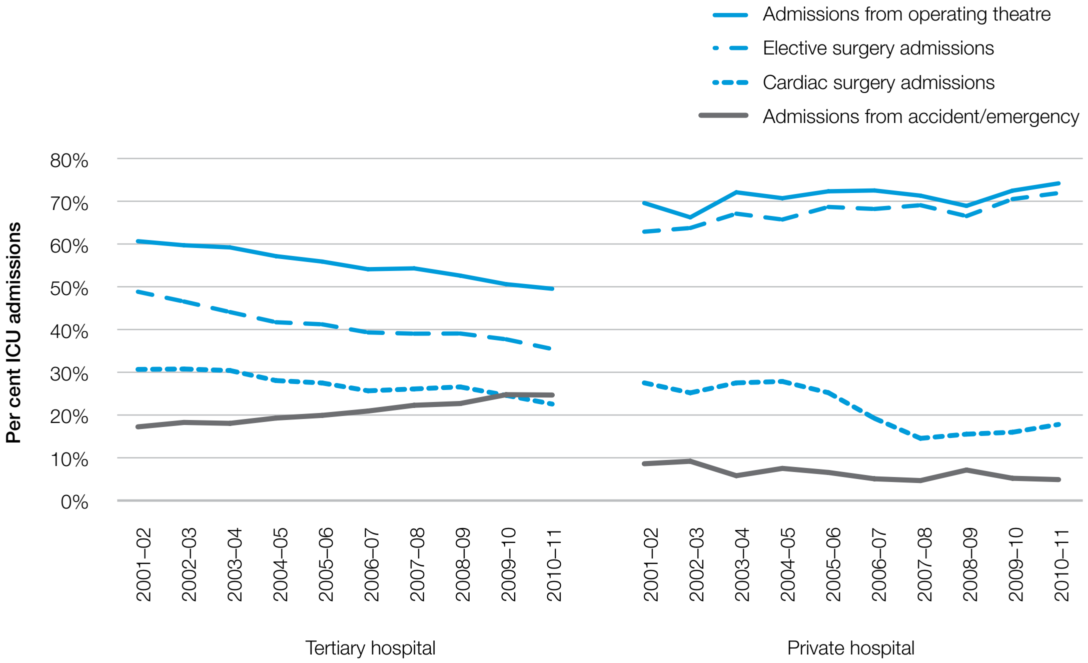
Table 9: Victorian private hospital ICUs

Hospital location	Hospital
Metropolitan	Cabrini Hospital, Malvern
	Epworth Eastern Hospital, Box Hill
	Epworth Freemasons, East Melbourne
	Epworth Hospital, Richmond
	John Fawkner Private Hospital, Coburg
	Knox Private Hospital, Wantirna
	Melbourne Private Hospital, Parkville
	Peninsula Private Hospital
	St Vincent's Private Hospital, Fitzroy
	The Valley Private Hospital, Mulgrave
	Warringal Private Hospital, Heidelberg
Regional/rural	St John of God Health Care, Ballarat
	St John of God Health Care, Bendigo
	St John of God Health Care, Geelong

Data collection resources are limited within these private hospital ICUs but nine submitted data to the ANZICS APD in 2010–11. Table 10 and Table 11 summarise data for the period 2001–02 to 2010–11, including comparisons with data from Victorian tertiary ICUs. While not all private ICUs have submitted data to APD over this period, the number of admissions reported has increased from 4,564 in 2001–02 to 7,309 in 2010–11, reflecting the important contribution of private ICUs to meeting the demand for intensive care services.

Figure 38 highlights the differences in casemix for private and tertiary public ICUs, with private ICUs catering mainly for patients following elective surgery. These differences are also highlighted in the top five admission diagnoses (Table 10 and Table 11), which further reflect the surgical focus of private ICU admissions as well as the decline in admissions for cardiac surgery across both public and private sectors due to the advent of less invasive techniques. Private hospital ICU admissions for orthopaedic surgery also account for a significant proportion of admissions (8.9% in 2010–11).

Figure 38: Source of private hospital and tertiary public hospital ICU admissions, 2001–02 to 2010–11



Source: APD

Note: Cardiac surgery admissions include coronary artery bypass graft and valvular heart surgery. Not all hospitals contribute to APD every year.

Table 10: Private ICU admissions, top five diagnoses, 2001–02 to 2010–11

Diagnosis 2001–02	Number (%) n = 4,564		Diagnosis 2010–11	Number (%) n = 7,309
Coronary artery bypass graft	914 (20.0)	1	Coronary artery bypass graft	698 (9.5)
Valvular heart surgery	353 (7.7)	2	Surgery for gastrointestinal neoplasm	670 (9.2)
Surgery for gastrointestinal neoplasm	214 (4.7)	3	Orthopaedic surgery	653 (8.9)
Surgery for musculoskeletal disorder	170 (3.7)	4	Valvular heart surgery	451 (6.2)
Surgery for other renal diseases	122 (2.7)	5	Surgery for other gastrointestinal diseases	418 (5.7)

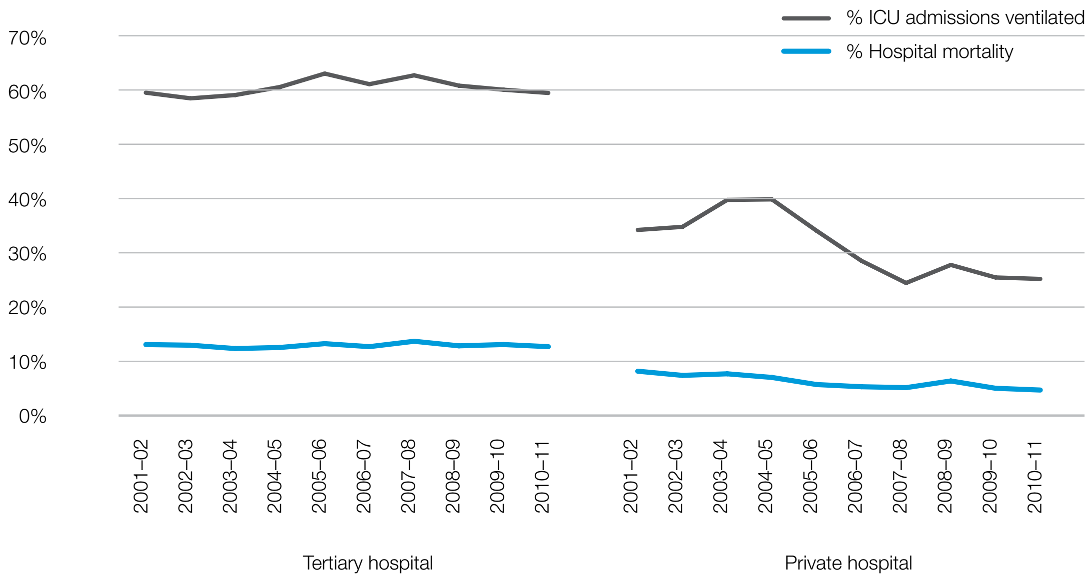
Table 11: Tertiary public ICU admissions, top five diagnoses, 2001–02 to 2010–11

Diagnosis 2001–02	Number (%) n = 6,606		Diagnosis 2010–11	Number (%) n = 10,704
Coronary artery bypass graft	1,615 (24.4)	1	Coronary artery bypass graft	1,504 (14.1)
Valvular heart surgery	424 (6.4)	2	Valvular heart surgery	584 (5.5)
Surgery for gastrointestinal neoplasm	217 (3.3)	3	Cardiac arrest	399 (3.7)
Surgery for other respiratory diseases	213 (3.2)	4	Sepsis with shock other than urinary	399 (3.7)
Surgery for head trauma +/- multiple trauma	193 (2.9)	5	Surgery for coronary artery bypass graft with valve repair/replacement	355 (3.3)

Source: APD
Note: Not all hospitals contribute to APD every year.

Reflecting the lesser severity of illness of patients in private ICUs, fewer of these patients required mechanical ventilation (25.9%) than tertiary patients (60.1%) in 2010–11, and length of stay in ICU was shorter (36.9 hours compared with 47.5 hours) (Table 12). In line with this, the severity of illness scores, predicted risk of death and hospital mortality were lower in private than in tertiary units (Table 13). The proportion of ventilated patients has declined over the 10-year period in private ICUs but not in tertiary ICUs (Figure 39).

Figure 39: Private hospital and tertiary public hospital admissions, 2001–02 to 2010–11 – per cent ICU admissions ventilated and per cent hospital mortality



Source: APD
Note: Not all hospitals contribute to APD every year.

Table 12: Private hospital and tertiary hospital ICU admissions, 2001–02 to 2010–11

	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11
Contributing sites										
Private	9	9	8	8	8	8	7	8	10	9
Tertiary	5	6	6	6	6	6	6	6	6	6
Admissions										
Private	4,564	4,623	4,582	4,162	4,936	4,712	4,045	4,669	5,947	7,309
Tertiary	6,606	8,473	9,815	9,161	9,041	9,479	9,500	9,822	10,241	10,704
Admissions ventilated (%)										
Private	34.9%	35.5%	40.4%	40.5%	34.7%	29.2%	25.1%	28.4%	26.1%	25.9%
Tertiary	60.2%	59.1%	59.7%	61.2%	63.7%	61.7%	63.4%	61.5%	60.7%	60.1%
Median age, years (IQR)										
Private	71.0 (59.2–78.4)	70.9 (59.2–78.4)	70.0 (59.0–78.6)	69.6 (59.2–78.5)	69.0 (58.8–78.7)	69.5 (58.9–79.3)	69.7 (58.9–78.9)	69.6 (58.8–79.4)	69.8 (59.6–79.5)	69.8 (59.5–79.4)
Tertiary	64.2 (50.1 –73.6)	65.0 (51.0–74.0)	64.6 (51.5–74.2)	65.0 (51.0–74.9)	64.5 (50.0–74.4)	64.0 (49.3–74.2)	64.4 (49.6–74.5)	63.7 (49.2–74.0)	64.0 (49.8–74.2)	63.4 (49.0–74.3)
Median ICU length of stay, hours (IQR)										
Private	39.7 (21.3–61.5)	40.7 (21.0–64.6)	40.0 (20.0–62.9)	41.4 (21.6–66.1)	40.0 921.3–63.8)	40.3 (21.0–64.3)	40.3 (21.3–64.3)	40.7 (21.8–66.9)	38.1 (20.5–62.7)	36.9 (20.4–61.3)
Tertiary	38.8 (19.8–86.5)	34.5 (19.5–75.0)	33.6 (19.5–73.3)	37.7 (20.2–82.7)	41.0 (21.0–88.5)	42.3 (21.6–90.7)	43.5 (21.8–93.0)	42.5 (21.3–93.5)	44.2 22.3–93.1)	47.5 (23.1–96.8)
Operating theatre admissions (%)										
Private	69.7%	66.3%	72.2%	70.8%	72.4%	72.6%	71.4%	69.0%	72.5%	74.2%
Tertiary	60.8%	59.8%	59.3%	57.3%	56.0%	54.2%	54.4%	52.7%	50.7%	49.7%
Emergency admissions (%)										
Private	8.9%	9.5%	6.1%	7.8%	6.9%	5.4%	5.0%	7.5%	5.5%	5.2%
Tertiary	17.5%	18.5%	18.3%	19.6%	20.2%	21.2%	22.5%	22.9%	25.0%	24.9%

Table 13: Private hospital and tertiary hospital ICU outcomes, 2001–02 to 2010–11

	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11
Hospital mortality										
Private	8.9%	8.1%	8.4%	7.7%	6.4%	6.0%	5.8%	7.1%	5.7%	5.4%
Tertiary	13.8%	13.7%	13.0%	13.2%	13.9%	13.4%	14.4%	13.5%	13.8%	13.4%
Risk of death										
Median APACHE III-J risk of death (IQR)										
Private	0.03 (0.01–0.10)	0.04 (0.01–0.12)	0.03 (0.01–0.11)	0.03 (0.01–0.11)	0.03 (0.01–0.09)	0.03 (0.01–0.09)	0.03 (0.01–0.09)	0.03 (0.01–0.10)	0.03 (0.01–0.08)	0.03 (0.01–0.07)
Tertiary	0.07 (0.02 –0.22)	0.07 (0.02–0.23)	0.07 (0.02–0.23)	0.06 (0.02–0.22)	0.06 (0.02–0.23)	0.05 (0.02–0.20)	0.05 (0.01–0.20)	0.05 (0.01–0.21)	0.06 (0.02–0.23)	0.06 (0.02–0.22)

Source: APD

Note: Not all hospitals contribute to APD every year.

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Appendices

Appendix 1: ICU separations for Victorian Hospitals contributing to the Adult Patient Database 2001-02 to 2010-11

Site	2001–02	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11
Tertiary										
Austin Hospital	1,692	1,740	2,006	1,834	1,833	2,030	2,049	2,037	2,090	2,112
Geelong Hospital	941	1,268	1,434	1,387	1,468	1,424	1,380	1,254	1,248	1,257
Monash Medical Centre		667	1,436	1,327	1,183	1,301	1,285	1,503	1,651	1,756
St Vincent's Hospital	1,090	1,200	1,195	1,100	1,151	1,053	973	1,129	1,231	1,369
The Alfred	1,924	1,682	1,687	1,443	1,612	1,716	1,775	1,863	1,986	2,108
The Royal Melbourne Hospital	959	1,916	2,057	2,070	1,794	1,955	2,038	2,036	2,035	2,102
Metropolitan										
Box Hill Hospital	432	483	542	555	646	588	671	725	779	887
Dandenong Hospital	547	531	527	503	428	475	937	1,199	1,220	1,277
Frankston Hospital	409	215	45	527	595	709	730	755	777	883
Maroondah Hospital	192		359	347	402	433	442	494	477	522
The Northern Hospital	526	506	655	696	736	804	809	743	776	799
Peter MacCallum Cancer Centre		1	275	317	319	334	325	404	488	467
Western Hospital		332	837	784	834	767	794			
Rural										
Albury Hospital*										252
Ballarat Base Hospital	384	33	617	662	694	703	637	60	670	678
Bendigo Hospital	5	478	447	477	449	629	616	628	627	533
Gippsland Base Hospital (Sale)				35	70	70	279	376	404	502
Hamilton Hospital								3	232	342
Horsham Hospital					103	391	318	365	395	372
Latrobe Regional Hospital (Traralgon)	300	341	333	298	267	270	339	378	383	523
Mildura Base Hospital				22	311	358	377	366	382	355
Shepparton Hospital	657	660	731	636	619	619	599	468	643	636
Wangaratta District Base Hospital	715	883	874	860	846	804	843	777	795	627
Warrnambool Base Hospital									158	417

* Albury contributed data under the New South Wales jurisdiction up until 2010, thus data from that period is not included in this table.

Appendix 2: Intensive care research

ICU research activities have been facilitated through the formalisation of intensive care research coordinator positions established from 1999 within ICUs. The coordinators have played a key role in the successful completion of several large ANZICS Clinical Trials Group studies over the past decade. In addition to managing the multicentre research studies, the research coordinator role provides a valuable resource, enabling participation in other research projects and supporting the conduct of quality assurance, teaching and audit activities. This contributes to a culture of evidence-based practice within ICUs and is a factor in attracting and retaining high-quality staff to the services.

Significant ICU-related research projects arising from the ANZICS Trials Group have included the:

- NICE-SUGAR project, which compared the use of intensive insulin treatment with standard care
- SAFE and CHEST trials, comparing the effect of intravenous fluids on kidney function and survival
- RENAL study, a randomised evaluation of normal versus augmented level of renal replacement therapy (RRT) in severe acute renal failure
- DECRA trial of surgical techniques in severe brain injury
- MERIT study of METs.

Research coordinator positions are funded by unit-based funding and via per patient payments arising from grants from the National Health and Medical Research Council and Intensive Care Foundation. The professional development of the role now sees many research coordinators involved in study management committees and in leading investigator-initiated trials.

The large amount of data generated locally and internationally through research activities and service monitoring has facilitated more standardised approaches to clinical management and to the development of guidelines and pathways. These include guidelines for sepsis management, nutrition, transfusion and many others. This approach, when combined with adequate numbers of well-trained staff, is believed to be an important factor in achieving consistency and quality in ICU.

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Definitions and abbreviations

Definitions of key terms used in this document

Intensive care unit (ICU)	An ICU is a specially staffed and equipped, separate and self-contained section of a hospital for the management of patients with life-threatening or potentially life-threatening illnesses, and reversible or potentially reversible organ failure.
High dependency unit (HDU)	An HDU is a specially staffed and equipped section of an intensive care complex that provides a level of care intermediate between intensive care and general ward care.
Paediatric intensive care unit (PICU)	A PICU is an ICU capable of providing comprehensive critical care including complex multi-system life support for an indefinite period to children aged younger than 16 years.
Critical care unit	A critical care unit is an ICU, PICU, combined ICU/CCU or combined ICU/PICU.
ICU-equivalent bed	An ICU-equivalent bed is a bed staffed to ICU standard (1:1 nurse to patient ratio). A PICU bed is considered an ICU-equivalent bed. HDU and CCU beds are staffed at a 1:2 nurse to patient ratio and therefore equate to 0.5 of an ICU-equivalent bed. This term only relates to Department of Health performance monitoring.
Physical bed	A physical bed is a single patient care location within a critical care unit.
Occupied bed	An occupied bed is a staffed ICU, PICU, HDU or CCU bed currently occupied by a patient as reported on the Retrieval and Critical Health (REACH) website.
Empty bed	An empty bed is a staffed ICU, PICU, HDU or CCU bed that is currently vacant as reported on the Retrieval and Critical Health (REACH) website.
Available bed	An available bed is an ICU, PICU, HDU or CCU bed that is either occupied or empty, according to the definitions used by Adult Retrieval Victoria for the Retrieval and Critical Health (REACH) website.
Operating capacity	Operating capacity is the number of ICU-equivalent beds available at any given time (calculated based on the reported number of available beds). Average operating capacity is the average number of ICU-equivalent beds available across a defined time period.
Bed occupancy	Bed occupancy is the percentage of available beds currently occupied and is a relevant measure for operational planning purposes because it links staffing and activity levels.
Bed utilisation	Bed utilisation is the percentage of physical beds that are currently available and is a relevant measure for longer term capital planning purposes because it indicates the level of unused physical capacity.
Minimum operating capacity	The minimum operating capacity of a critical care unit is defined as the number of ICU-equivalent beds that should be provided daily. It is a target set for health services within their annual Statement of priorities and defines the minimum level of critical care unit operating capacity that health services agree to provide within their overall annual funding allocation.

Abbreviations

ANZICS	Australian and New Zealand Intensive Care Society
ANZPICR	Australian and New Zealand Paediatric Intensive Care Registry
APACHE	Acute Physiology, Age and Chronic Health Evaluation
APD	Adult Patient Database
CICM	College of Intensive Care Medicine
CCR	critical care resources
CCU	coronary care unit
COPD	chronic obstructive pulmonary disease
CORE	Centre for Outcome and Resource Evaluation
COPE	critical care outcome prediction equation
ECMO	extracorporeal membrane oxygenation
FTE	full-time equivalent
HDU	high dependency unit
ICU	intensive care unit
IQR	interquartile range
MET	medical emergency team
MTS	major trauma service
PICU	paediatric intensive care unit
SMR	standardised mortality ratio
VAED	Victorian Admitted Episodes Dataset
VICDRC	Victorian Intensive Care Data Review Committee