clabICU PROJECT

PREVENTING CENTRAL LINE INFECTIONS

ICCMU
Intensive Care Coordination & Monitoring Unit

NSW HEALTH

CLINICAL EXCELLENCE COMMISSION

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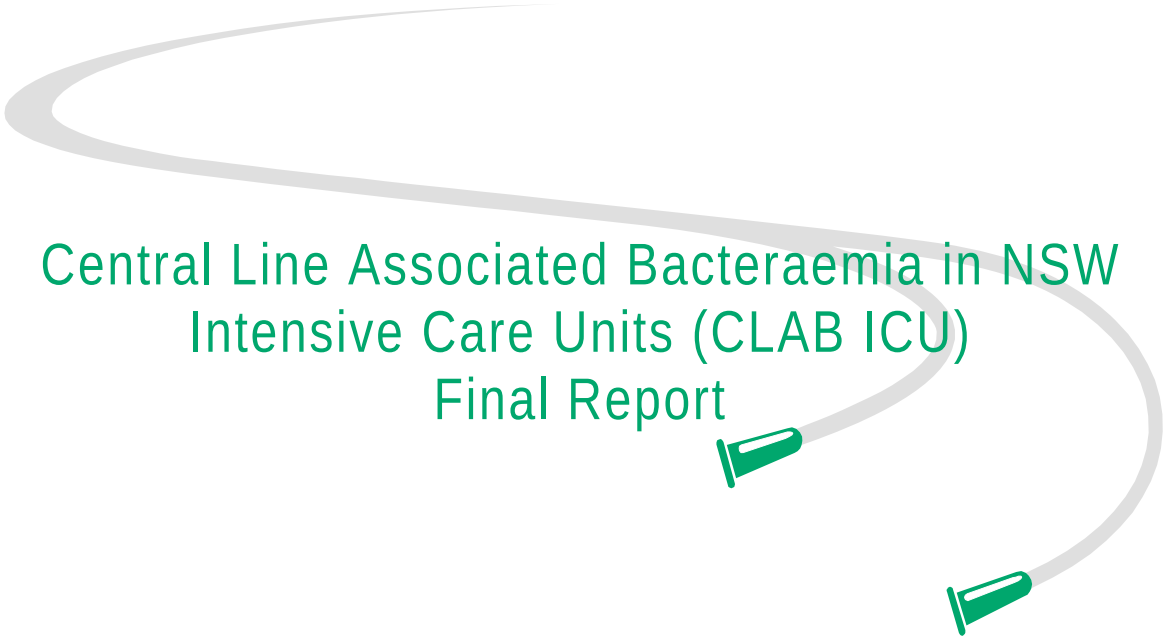
Central Line Associated Bacteraemia in NSW Intensive Care Units (CLAB ICU) Final Report



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Executive Summary

Central line insertion is a common procedure in hospital. Most intensive care unit (ICU) patients have a central line inserted during their stay. Central Line Associated Bacteraemia (CLAB) is a known infective complication of central line insertion and can lead to serious illness. These infections require significant treatment, leading to an extended stay in hospital. The majority of CLAB events are considered to be preventable. The evidence suggests that the risk of CLAB can be reduced to almost zero using simple techniques.

The Central Line Associated Bacteraemia in NSW Intensive Care Units (CLAB ICU) project began in March 2007. It was conducted by the Clinical Excellence Commission (CEC) and the Intensive Care Coordination and Monitoring Unit (ICCMU), with the support of NSW Health, using a 'top–down bottom–up' approach. All adult intensive care units in NSW and paediatric ICUs at Sydney Children's Hospital and The Children's Hospital at Westmead participated.

The project promoted a standard aseptic insertion technique to minimise the risk of CLAB. This was based on the premise that CLAB is causally related to contamination from the patient's skin flora or contamination by the clinician inserting the central line.

The project was modelled on an international initiative which promoted a clinical practice bundle to reduce infections and used a collaborative methodology (Pronovost, et al, 2006). NSW Health performance targets of 20 per cent reduction of ICU CLABs by January 2008 and 80 per cent by June 2010 added incentive for chief executives to promote participation within the ICU.

The project resulted in the reduction of CLABs in NSW ICU patients by 60 per cent by December 2008. Data collected subsequent to completion indicates that the results have been sustained.

Other notable outputs and outcomes include:

- A comprehensive guideline for the percutaneous insertion of central lines (guideline)
- Standard sterile equipment in a pack available for use across NSW adult ICUs
- Online data collection and reporting system
- Education and training framework
- Online education package
- A request for a safety alert regarding lost guidewires
- Adaptation of the data collection tool/checklist into a statewide central line insertion record (CLIR) for use throughout hospitals.

Summary of Recommendations

The CLAB ICU project successfully implemented a framework to reduce the CLAB rate in NSW ICUs. To continue and sustain the benefits to patients it is recommended that NSW Health facilitate statewide implementation of the project outputs.

Recommendation 1	The central line insertion record (CLIR) is released for use
Recommendation 2	The CLAB ICU central line insertion guideline is released as a policy document for use hospital and statewide
Recommendation 3	The central line insertion training framework and online training module are released for use
Recommendation 4	Data collection and verification be a shared responsibility between the ICU and other specialties, such as infection control, with the support of microbiology and infectious diseases specialists
Recommendation 5	Education is provided to all staff applying the ICU CLAB surveillance definition
Recommendation 6	NSW Health support ongoing use of the online database

Acknowledgement

The success in reducing the incidence of CLABs in NSW ICU patients is largely attributable to the hard work of the clinicians who supported the project in their ICU and who guided its development through the expert group and steering committee.

This report was compiled by Margherita Murgo and Eda Calabria (CEC project officers).

Introduction

Background

A central line, or central venous catheter, is an intravenous line used for giving patients fluids and/or medications. It may be used when a patient's arm veins are difficult to access with a small catheter (cannula), or when certain medications or nutrients cannot be administered into the smaller veins found in the arm (ICCMU, 2008).

A central line is inserted into a large vein in the body. These are found in the neck (jugular), the front of the shoulder (subclavian) or the groin (femoral). In some patients, a central line may be inserted into the vein of the elbow and advanced into the subclavian vein. This type of catheter is known as a peripherally inserted central catheter or PICC line (ICCMU, 2008).

Although the insertion of a central line can be lifesaving, infection is sometimes a serious complication. A Central Line Associated Bacteraemia (CLAB) is a bloodstream infection associated with a central line where the central line is considered to be the source of bacteria or microorganisms. These microorganisms can lead to serious illness and the infections require significant treatment, leading to an extended stay in hospital.

Local Problem

NSW Health has required reporting of CLAB rates since 2003. CLAB is monitored in intensive care units as these infections are responsible for 40-60 per cent of healthcare associated bloodstream infections in ICU patients and their occurrence is a key indicator of the safety of the ICUs clinical practice processes (NSW Health, 2008).

Prior to the start of the CLAB ICU project in July 2007, approximately 285 CLABs, resulting in an estimated loss of up to 34 lives, occurred in NSW ICUs each year (Bendall, 2007). Expenditure on CLABs at that time was estimated at $8.3 million per annum (Bendall, 2007). There was, however, uncertainty about the accuracy of this data.

- Only 35-58 per cent of ICUs were reporting.
- The reporting was often done in isolation from ICU.
- Data collection was not continuous.

Purpose

The primary objective of the project was to achieve a measurable reduction in CLAB in NSW ICUs. The objective was initially defined by area health service agreements as a 20 per cent reduction by January 2008 and a further 80 per cent by January 2010. After results started to be reported and when service agreements were due for revision, targets were modified, to focus on process measures of compliance with the standard insertion practice.

Project Outline

The Central Line Associated Bacteraemia in NSW Intensive care units (CLAB ICU) project was conducted by the Clinical Excellence Commission (CEC) and the Intensive Care Coordination and Monitoring Unit (ICCMU), with the support of NSW Health. All adult intensive care units in NSW and paediatric ICUs at Sydney Children's Hospital and The Children's Hospital at Westmead participated.

The project intervention was based on the premise that the majority of CLAB is related to contamination of the line at the time of insertion from the patient's skin flora, or contamination by the clinician inserting the central line. The project therefore promoted a standard aseptic insertion practice, which aimed to minimise opportunity for contamination and sensitised staff to inadvertent breaches of aseptic technique. The project did not change the method of insertion, but rather focussed on the preparation of the patient and clinician.

Timeline

The project was to be conducted between March 2007 and December 2008. There was an additional business case submitted to NSW Health to extend funding to embed the project to June 2009.

This timeline has been exceeded due to adjustments to the project scope and because the CEC is still managing the online database and fielding questions around the ICU CLAB clinical indicator.

Funding and Budget

Funding for the project was provided by NSW Health to support implementation and management of the project by the CEC. The accepted budget proposals totalled $792,647, including $541,047 for the original project scope and $251,600 for the extension. Actual expenditure totalled $508,831, $283,816 less than originally budgeted. The breakdown of expenditure appears in Appendix 1.

MRO funding was provided to Area Health Services to support implementation on the recommendations of the NSW expert group on MRO. Reduction of CLAB ICU was a performance indicator related to this allocation of funds. Most sites reported having no access to funds for change processes throughout the project. Sites that were able access to MRO funds purchased equipment or supported temporary project officers. One area health service used funds to purchase relevant software to keep a separate database.

Ethical Issues

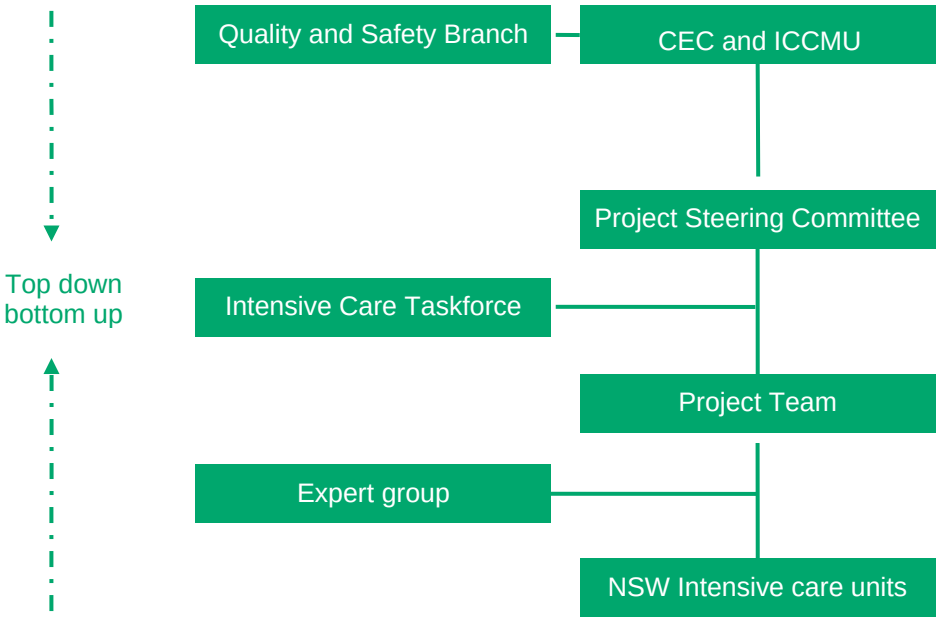
The NSW Department of Health Clinical Ethics Branch deemed the CLAB ICU project to be a quality improvement activity, which did not require ethics approval.

Methodology

The CLAB ICU project was designed using a 'top–down bottom–up' approach. Project principles and objectives were set from above by NSW Health, the CEC and ICCMU. Tool design, networking and implementation were driven by clinicians from the bottom–up.

The CEC and the ICCMU were responsible for managing the project, with support from expert and steering committees. The CEC project team is listed in Appendix 2.

Figure 1: PROJECT ORGANISATIONAL STRUCTURE



Guideline and Checklist Development

An expert group of senior nursing and medical intensive care physicians was convened to develop a guideline for central line insertion, from which the main project outputs were derived.

The guideline was developed with reference to the Queensland Government Centre for Healthcare Related Infection Surveillance and Prevention (CHRISP) Percutaneous Central Venous Catheter Recommended Practices (Queensland Government, 2007) and the Centers for Disease Control and Prevention's Guidelines for the Prevention of Intravascular Catheter-Related Infections (O'Grady, et al, 2002). The guideline was refined by ICU clinicians at project workshops and regularly reviewed by the CLAB ICU expert group (See Appendix 3 for document history).

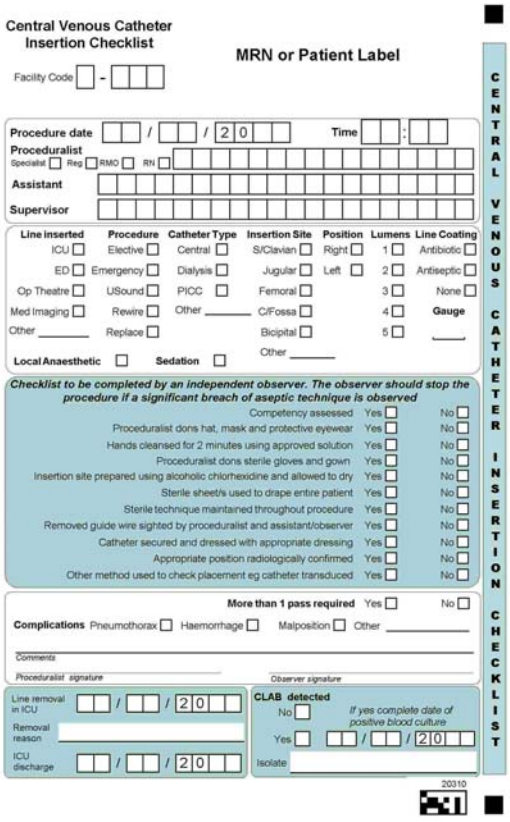
The CLAB ICU guideline promoted compliance with hand hygiene, skin preparation and full barrier precautions. The expert group recommended the following insertion technique:

- Proceduralist dons a hat, mask and protective eyewear
- Proceduralist cleanses hands for two minutes using an approved solution
- Proceduralist wears sterile gloves and gown
- Insertion site is prepared using alcoholic chlorhexidine (1-2 per cent) and allowed to dry
- Entire patient is draped using a sterile sheet
- Proceduralist maintains sterile technique throughout the procedure
- Catheter is secured and then covered with a sterile transparent semi–permeable self–adhesive dressing.

To support compliance with the guideline and to facilitate data collection, the recommended insertion technique was incorporated into a checklist developed by the CLAB ICU expert group. The checklist was revised throughout the project, in consultation with participating ICUs.

Participating ICUs were to complete the insertion checklist for central lines inserted within the unit. Some sites elected to use it as a record of central line insertion to be kept in the patient's notes. Some sites also encouraged its use outside the ICU.

A proceduralist or assistant was to complete the checklist following the insertion of a central line. The checklist also required reporting of other details about the procedure, including the insertion site, type of line and complications such as pneumothorax, haemorrhage and malposition and the incidence of CLAB.


Central Venous Catheter Insertion Checklist

MRN or Patient Label

Facility Code

Procedure date / / 20 Time :

Proceduralist

Specialist Reg RMO RN

Assistant

Supervisor

Line inserted	Procedure	Catheter Type	Insertion Site	Position	Lumens	Line Coating
ICU	Elective	Central	S/Clavian	Right	1	Antibiotic
ED	Emergency	Dialysis	Jugular	Left	2	Antiseptic
Op Theatre	USound	PICC	Femoral		3	None
Med Imaging	Rewire	Other	C/Fossa		4	Gauge
Other	Replace		Bicipital		5	
			Other			

Local Anaesthetic Sedation

Checklist to be completed by an independent observer. The observer should stop the procedure if a significant breach of aseptic technique is observed

Competency assessed	Yes	No
Proceduralist dons hat, mask and protective eyewear	Yes	No
Hands cleansed for 2 minutes using approved solution	Yes	No
Proceduralist dons sterile gloves and gown	Yes	No
Insertion site prepared using alcoholic chlorhexidine and allowed to dry	Yes	No
Sterile sheet/s used to drape entire patient	Yes	No
Sterile technique maintained throughout procedure	Yes	No
Removed guide wire sighted by proceduralist and assistant/observer	Yes	No
Catheter secured and dressed with appropriate dressing	Yes	No
Appropriate position radiologically confirmed	Yes	No
Other method used to check placement eg catheter transduced	Yes	No

More than 1 pass required Yes No

Complications Pneumothorax Haemorrhage Malposition Other

Comments

Proceduralist signature Observer signature

Line removal in ICU / / 20

Removal reason

ICU discharge / / 20

CLAB detected

No

Yes If yes complete date of positive blood culture / / 20

Isolate

20310

CENTRAL VENOUS CATHETER INSERTION CHECKLIST

To see a full size version click here

Clinician Engagement

Clinicians were engaged at various stages of the project. Initially, an orientation workshop in June 2007 for clinicians and others involved in the project explained the purpose, collaborative methodology, identified issues and provided an opportunity to create linkages between ICUs, clinical governance representatives and microbiologists.

A subsequent session in November 2007 provided participating sites with the opportunity to share their successes and give feedback on the progress and utility of the project.

An open – floor session was used to discuss barriers to implementation and suggestions for improvement of implementation of the project at a local and statewide level. Smaller workshops were later used to develop the content for a standard education and training framework and an e-learning package. All information was posted on the CEC website for further reference (CEC, 2008).

ICUs were asked to form improvement teams, with medical and nursing representation identified from within existing staff. The team communicated with the CEC project team for support, advice and results. Members of the project team also visited ICUs.

The project coordinator conducted unstructured monthly teleconferences for teams from tertiary, referral, metropolitan and rural hospitals in the first twelve months and thereafter bi-monthly. The purpose of these was to create a support network for improvement teams, keep participants abreast of developments and to create a forum where teams could ask questions, raise concerns and influence the implementation of the project on a statewide level.

The list serve 'ICUConnect' was used to facilitate communication (Rolls, Kowal, Elliott & Burrell, 2008). "ICUconnect" is an email communication list, with more than 1000 clinicians receiving emails related to ICU topics. It was used to circulate the bi-monthly ICCMU newsletter in which regular reports, feedback from the project team, relevant articles and responses to central line related questions were published. The project team also regularly communicated via email and letters to participating sites.

Data Collection

The CEC facilitated centralised data collection, collation and reporting to participating ICUs from July 2007. The project team conducted data integrity checks and followed–up missing or improbable data and confirmed the validity of reported CLABs with individual ICUs. Regular reporting to ICUs was considered essential to maintain clinician engagement and to facilitate quality improvement and change.

The project team transitioned data collection through three phases (see Table 1) and now 33 ICUs regularly contribute to an online database. Difficulties were encountered regarding data collection and associated information technology. The project team resorted to receipt of hard copy checklists in October 2007 and manual data entry in August 2008. This posed a significant risk to the project and was allocated the highest risk rating because of the time and human resources involved.

Table 1: DATA COLLECTION PHASES

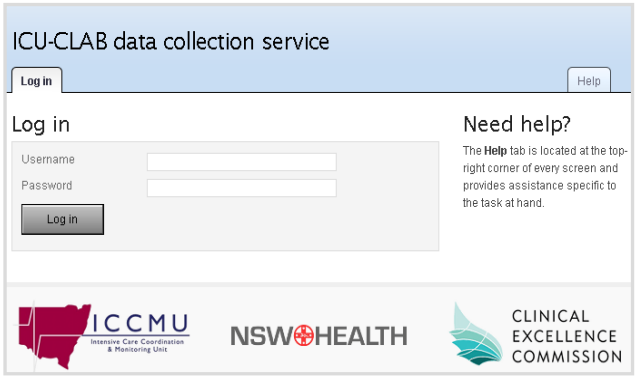
Phase	Process
1	Line specific data collection for inclusion in a cumulative database. Intensive follow-up processes required by the CEC and ICUs. This process reinforced ownership and accuracy of CLAB results.
2	A transition phase to collection of line days through internationally accepted tallies using spreadsheets (O'Grady, et al, 2002).
3	Transition to an online data collection system that supports adherence to definitions and data collection processes in line with NSW Health.

Online Data Collection and Reporting System

NSW Health planned a system for collecting clinical indicator data which was not available at project's end. A variety of options were explored to ensure sustainability of reporting with an emphasis on ICU ownership. The lack of a continuous and sustainable data collection system involving cross–speciality collaboration was seen as a serious risk to sustainability of the CLAB ICU principles.

To ensure that reporting of ICU CLAB indicator data continued, independent of the CEC, an online data collection and reporting system was developed. The design has the potential for improvement of functionality with multiple advanced options. The key features of the system are:

- Online data entry of denominator and numerator data
- Real–time online process control charts
- Access to statewide data for further analysis.



The custody of the online database was intended to transition to NSW Health and merge with the clinical indicator data collection system. This has not yet occurred.

Definitions

The CLAB ICU project adopted the definition for CLAB in accordance with the NSW Department of Health surveillance definition (2005)(NSW Health, 2005) and the Centers for Disease Control definition of CLAB at that time (O'Grady, et al, 2002) with one exception. Only CLABs occurring in patients in the ICU or within 24 hours of transfer out were to be reported on the checklist. The 24–hour limit was adopted to reduce data collection burden on ICU improvement teams.

The definition required reporting of CLABs in the following circumstances:

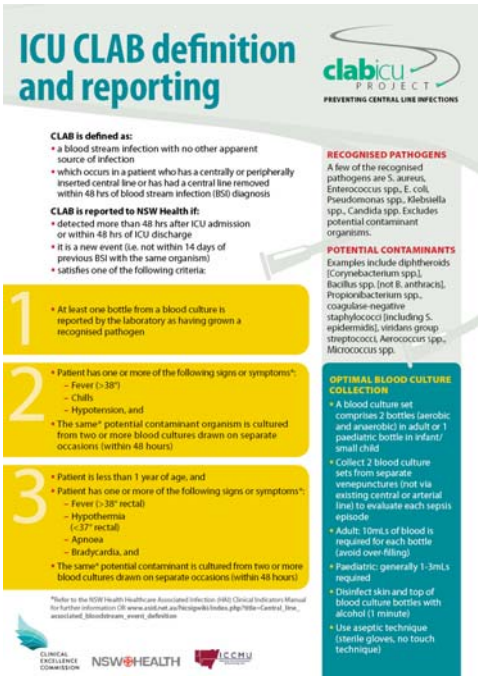
1. The cultured organism is not related to an infection at another site and
2. The presence of a recognised pathogen cultured from one or more blood cultures or
3. The presence of fever (>38°C),chills or rigors; or hypotension within 24 hours of a positive blood culture being collected and at least one of the following:
    - isolation of the same potential contaminant from two or more blood cultures drawn on separate occasions within a 48-hour period (isolates identified by suitable microbiological techniques)
    - isolation of a potential contaminant from a single blood culture drawn from a patient with an intravascular line (within 48 hours of the episode) and appropriate antimicrobial therapy against that isolate is commenced.

The definition of a reportable CLAB changed in the November 2008 version of the NSW Department of Health surveillance manual (NSW Health 2008), in response to a change to the Centres for Disease Control (CDC) CLAB definition. CLAB ICU participants were asked to adopt the revised definition on 1 January 2009, after data collection for the project ceased.

CLAB rates were reported using the accepted reporting method of CLAB/1000 line days. The data item *central line days* represents the difference between the date a central line was inserted and the earlier of the following two dates: removal date or ICU discharge. ICU discharge was used as a proxy end date, as it was not practical or sustainable to follow–up central lines into the ward and note the date of removal.

Central line days were calculated based on each line inserted, to allow more precise calculations of CLAB events and increase statistical relevance, as opposed to a proxy count of patients with lines in situ on a given day (tally data).

Given the debate about validity of the pre-existing data, CLAB rates were calculated for the first 12 months of the project as a run-in period and compared with the last six–month period. The run in period of 12 months was selected on the premise that a substantial period is required to allow for supportive changes to ICU processes and behaviour change.



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Reporting

Uptake of the project was staggered and a small percentage of units were late to start. This was due in some cases to ICU preparation or reluctance to change.

Monthly reports were issued listing the ICUs compliance with the advocated aseptic technique, the number of CLABs reported by the ICU, its CLAB rate per 1000 central line-days and weighted moving average CLAB rate per 1000 central line-days. Aggregated State results for all participating ICUs were reported alongside the individual ICU results.

Compliance was split into a patient bundle and a clinician bundle. The items listed in the bundles and the report layout is illustrated in Figure 2.

Figure 2: CLINICIAN AND PATIENT BUNDLE COMPONENTS

	Your Hospital			All Hospitals		
Clinician Bundle Breakdown	**Yes**	**No**	**Incomplete**	**Yes**	**No**	**Incomplete**
Undertake Competency						
Cleanse Hands						
Wear Hat, Mask, Eyewear						
Sterile Gloves, Gown						

	Your Hospital			All Hospitals		
Patient Bundle Breakdown	**Yes**	**No**	**Incomplete**	**Yes**	**No**	**Incomplete**
Prepare Procedure Site						
Cover Patient with Sterile Sheet						
Check Line Position						

An ICUs CLAB rate was calculated as the number of reported CLABs, divided by the number of ICU central line days for that ICU. Central line days were calculated based on information recorded on the checklists.

Some reports were accompanied by additional analysis of specific issues, such as complications, ongoing participation or compliance with a particular element of the two bundles.

Participation by individual ICUs was monitored throughout the intervention period. Reports were withheld and ICUs and clinical governance units notified, when an ICU failed to submit data for three consecutive periods.

Interim site reports were first distributed to participating sites and NSW Health in October 2007 and reissued in mid–November 2007, in an improved format. Software problems delayed earlier dissemination of results. Reports were also issued to area health service clinical governance units and NSW Health monthly and quarterly respectively.

Internal Project Evaluation

Multiple methods of evaluation were used throughout the project, to assess participation, areas of excellence and areas for improvement centrally and locally. The project team assessed the incidence of CLAB events, data submission, data quality and participation to evaluate the effectiveness of the project and influence practice. The number and regularity of checklist submission by ICUs individually and the statewide level was used as a proxy for participation. Participation in meetings and teleconferences was also considered. Sites were followed up when a drop in participation was noted through these measures. See Appendix 4. Participation measured in this way demonstrated consistent uptake.

Outliers were identified by number of reported CLAB or CLAB rate and number of checklists submitted. These units were subject to additional data analysis to provide insight and promote local improvement processes.

A number of units adopted the project principles months after the project started. This formed part of the argument for its continuation until December 2009. The issues included:

- Reticence to complete the checklist, due to fear of punitive consequences, particularly in regards to credentials.
- Evidence sceptics – some clinicians were in doubt of the evidence, even with the supportive CDC guidelines. The project methodology was based on a single successful large collaborative (Pronovost, et al, 2006) without a detailed analysis of all available evidence. This allowed criticism of methodology to be an excuse for non–compliance.
- Problem sceptics – inability of individual units to generalise the scope of the problem on a statewide level.
- Data sceptics – reliable baseline data did not exist prior to this project, due to variable reporting mechanisms. Some ICUs were hesitant to accept previously reported rates.

Results

Improvement in Compliance Rates

Compliance with aseptic insertion improved over the project lifespan. Checklists recording compliance were sometimes completed by proceduralists when assistance was not available. The hazard of self–reporting by proceduralists is acknowledged, however, the method of reporting was consistent throughout the project and therefore the measurable improvement is considered a valid indicator of success.

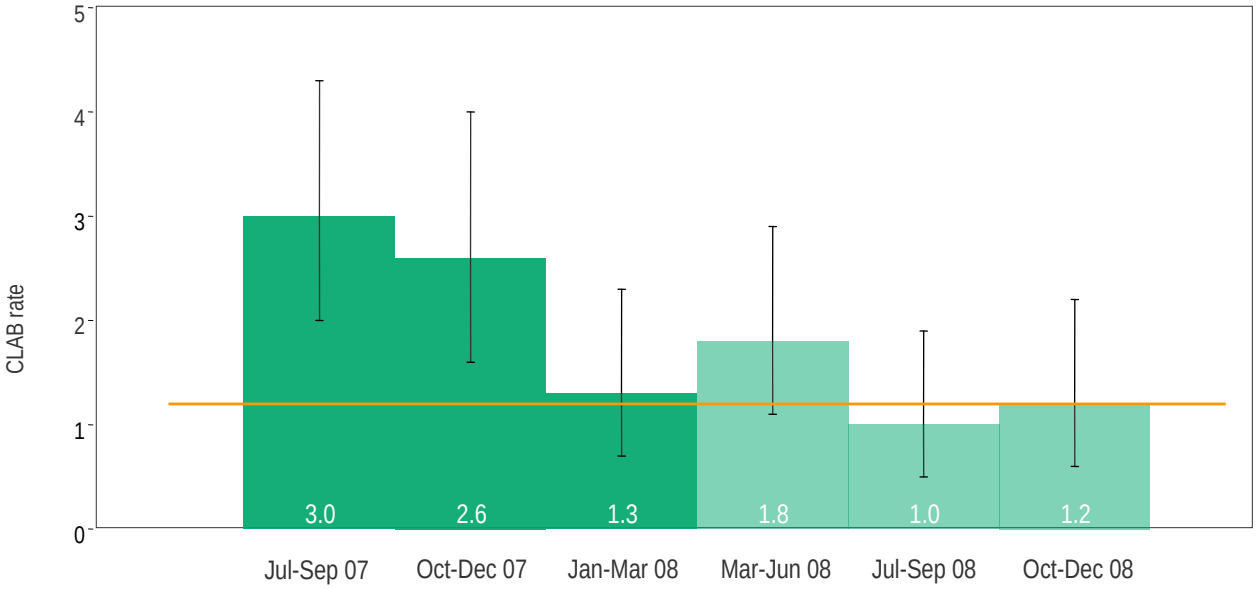
Compliance with the clinician bundle improved to 81 per cent by the end of the intervention period. Non-compliance with the clinician bundle was shown to significantly increase the risk of CLAB. 94 per cent of non compliance with the clinician bundle was attributed to failure to wear hat, mask and eyewear. This may be related to clinician scepticism about the evidence for the relationship between hat wearing to CLAB reduction. Overall, the evidence suggests that wearing hats is a pragmatic and reasonable step during central line insertion. Hat wearing is routinely cited as an element of clinician preparation in studies that have demonstrated a reduction in CLAB (Berenholtz, et al, 2004, Pronovost, et al, 2006), but non-hat wearing can not be directly linked to increased CLAB rates. However non hat wearing may be a proxy for other cultural or practice issues.

Compliance with the patient bundle was good throughout the project and improved significantly from 81 per cent at start to 92 per cent by the end of the project.

Reduction in the CLAB Rate

The NSW ICU CLAB rate reduced from 3.0/1000 to 1.2 /1000 central line–days over the 18–month project. The drop equates to a 60 per cent reduction. This has been calculated by comparing the results of the run–in period (the first 12 months) with the last six months of the project.

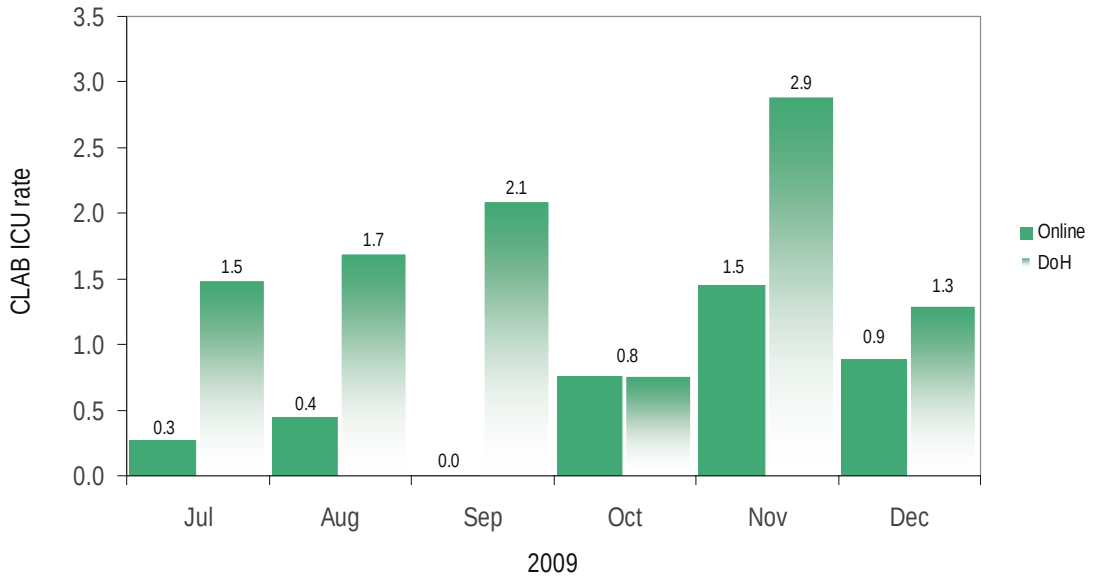
Figure 3: AGGREGATE CLAB ICU RATE PER 1000 LINE DAYS BY QUARTER



The data set was closed for analysis on 13 February 2009. There were 11,575 checklists analysed for the 18–month period. Although the dataset used in the analysis of the project outcomes is large, not all central lines inserted during the examined period were reported. A data quality initiative with three test sites was conducted to assess data capture. Based on these results, it is estimated that data on less than 50 per cent of inserted central lines during the period was captured. With consideration of the internal evaluation of participation, however, the dataset is considered to be a representative sample and therefore the results may be generalised with caution.

The NSW Healthcare Associated Infections Data Collection, which is based on collecting line days using a proxy (the tally method), as opposed to line specific data, reported quarterly CLAB rates for January to December 2009 which are lower than the rates for the same period in 2008, suggesting that the success of the project is being sustained in the short term. Analysis of data collected via the online system since July 2009, also shows a rate comparable to project's end. The graph below compares data reported through the NSW clinical indicator process as published on the NSW Health website, compared with the results reported through the online system. The data collection for both systems uses the same definitions. The difference is difficult to explain as a data comparison was requested and has not taken place.

Figure 4: COMPARISON OF CLAB ICU RATE PER 1000 LINE DAYS IN 2009 BY QUARTER



Reduction in Mortality

Using an average CLAB rate reduction of 50 per cent, and assuming the incidence of CLAB persisted at the baseline rate of 3.0 per 1000 patient line days for the duration of the project, 54 CLABs were avoided throughout the period. Patients that acquire blood stream infections have a significantly higher mortality than patients with no blood stream infection (Laupland, Kirkpatrick, et al, 2004). CLABs have an attributable mortality of between 10 and 35 per cent (Zack, 2008) so if 54 CLABs were avoided, using the conservative number of 10 to 15 per cent between 5 and 8 lives have been saved, as well as a significant number of days in ICU.

Reduction in Costs

In the absence of firm Australian data (Collingnon, 2007) regarding the additional costs associated with CLAB, US data has been used to estimate cost savings associated with the project. In the US, an episode of CLAB costs between $40,179 USD (Rosenthal, 2009) and $83,569 USD (Shreve, 2010). Using the more conservative figure of AUD 44,000 (1 USD=0.92 AUD) and using the estimate of 54 avoided CLABs, savings attributable to the project equate to $2.4 million. The validity of using US figures to estimate Australian savings is uncertain, however, the figure provides an indication.

Increased Patient Safety and Clinical Care

In addition to the development of the guideline and checklist, a number of resources were collaboratively developed to enable compliance with the advocated technique. The project also gave rise to some positive consequential outputs including:

- Education and training framework including an e-learning tool
- Standard sterile equipment pack available for use across NSW adult ICUs
- A request for a safety alert regarding removal of guidewires
- Adaptation of the checklist into a central line insertion record for use hospital wide

Education and Training Framework

Feedback from participating clinicians, statewide incident reports and root cause analysis illustrated that central line insertion training and competence varied widely across NSW and contributed to serious adverse events. Clinicians supported the need to standardise practice. Reasons include the mobility of the medical workforce, variable supervision and absence of a system to assess current competence.

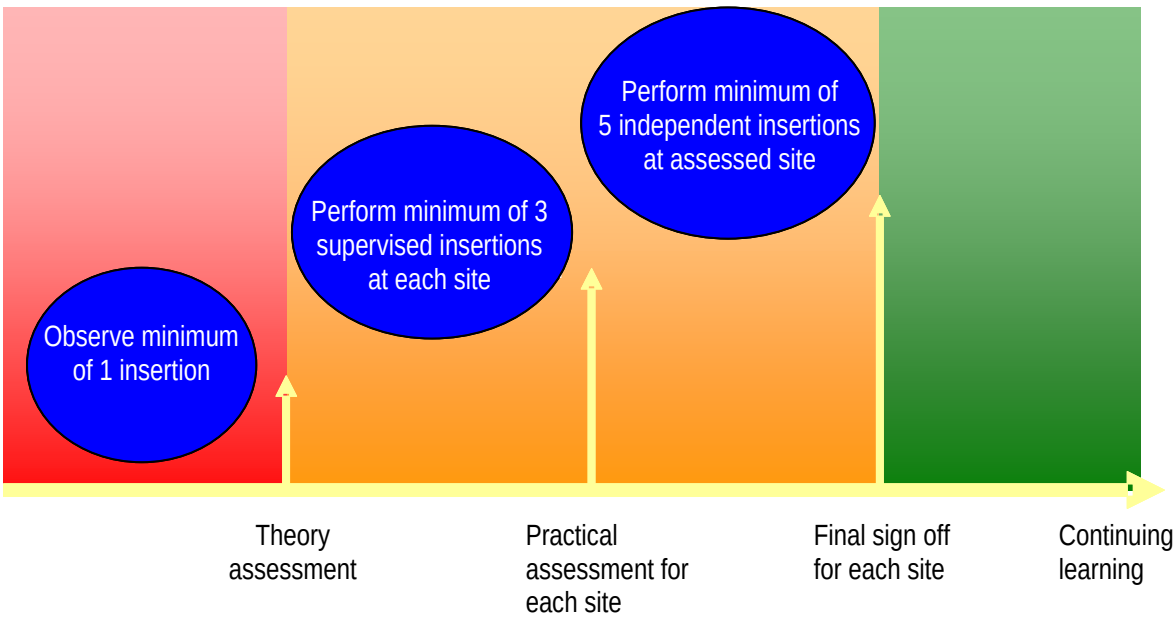
The project team canvassed participating units and found a minority had established credential processes. Existing requirements were inconsistent and subject to individual preferences or biases.

Why have a standard training approach?

- Support introduction of training at all ICUs.
- Standardise training of clinicians. Clinicians are particularly mobile during their training and training was subject to local idiosyncrasies.
- Introduce standardised assessment practices with a view to future credential processes. The clinicians identified this need.

Available local and international resources specific to central line insertion were collated and mapped for commonalities, to devise a single tool. A draft was developed to specify training requirements for safe insertion of central lines in adults in NSW. Congruence with international programs, including the Competency Based Training in Intensive Care Medicine for Europe (CoBaTrICE–European Society of Intensive Care Medicine) and existing national curriculum frameworks, such as the Australian Curriculum Framework for Junior Doctors (Confederation of Postgraduate Medical Education Councils), were assessed. The composite draft was refined by clinicians at project workshops where minimum training, supervision and assessment requirements were agreed. The framework outlines the minimum knowledge and practical requirement for training clinicians to insert central lines.

Figure 5: SUMMARY OF THE THEORETICAL AND PRACTICAL REQUIREMENTS OF THE EDUCATION FRAMEWORK



Online Education Package

An e-learning tool to support the reduction of CLAB in NSW was completed in July 2010 as part of the original CLAB ICU project scope. The education and training framework was considered to be a sound basis for supporting the development of the tool. The tool was expected to meet and assess the knowledge requirements of the training framework. Development by Edmore Consulting was approved in July 2008. The delay in completion has been multifactorial and included reliance on clinicians volunteering time. The online tool is yet to be released to clinicians.

Standard Sterile Equipment

A sterile procedure pack was developed for use by ICUs. The pack facilitates and sustains compliance with the advocated aseptic technique and ensures consistency in preparation for the procedure. Packs in use at various ICUs were examined and rated for usefulness at the first learning session. Through extensive consultation, development and field testing, a final sterile procedure pack was made to order in June 2009 via HealthSupport. Feedback will be monitored by the provider and the contents list reviewed annually to ensure currency.

Why have a standard pack?

- Support procedure preparation.
- Standardise equipment to assist staff who work at multiple hospitals.
- Promotes compliance with the guideline.
- Reduces need to scavenge equipment.
- Increase use to drive prices down.

Request for a Safety Alert

A review of central line insertion data from the Incident Information Management System from July 2006-March 2008 identified a number of issues, including retention of guidewires. See Appendix 5 for an overview of the data.

The review included more than 450 central line incidents, ranging in severity of outcome and included patient death. The data contained narratives about possible contributing factors and confirmed variability in training, supervision and skill amongst junior clinicians and difficulty assessing locum competency.

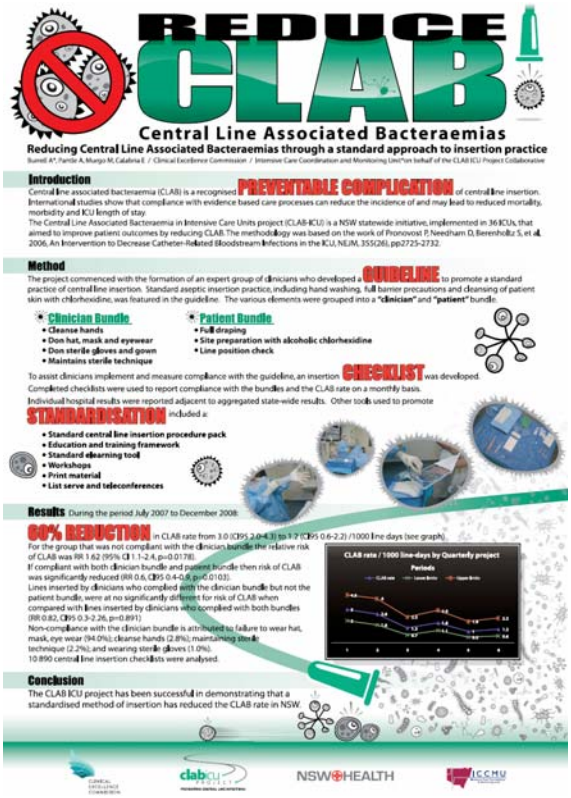
While the exact cause of the incidents could not be determined, likely factors that were considered included:

- Loss of control of the guidewire during insertion, arising from inexperience with Seldinger technique and/or insufficient supervision
- PICC guidewires inadvertently left in situ post chest x-ray position confirmation.

In May 2008 the CLAB ICU steering committee requested the safety alert brief decision group to consider issuing a Safety Alert regarding guidewires. A safety alert was issued by NSW Health on 16 June 2009. Actions required by area health services can be found on the NSW Health website.

Statewide insertion record

Because the checklist was used with success in the ICU, it was adapted by a representative working party into an insertion record for hospital and statewide use. Various specialities including anaesthesia, emergency medicine, paediatric intensive care, infection control, microbiology, central line insertion services and radiology provided feedback through a consultation process facilitated by the CEC. The publication of this record enables areas to comply with Guidewire Safety Alert No 002/09.



To see a full size version click here

Presentations

Results of the CLAB ICU project and the lessons learnt that influence clinician practices were disseminated in multiple forums. A list of conference presentations appears in Appendix 6. Two presentations received awards at their respective meetings. The pictured poster received third prize at the International Forum on Quality and Safety in Health Care. Two publications are currently under consideration in peer-reviewed journals.

Other Notable Outcomes

The following additional system outcomes which contribute strongly to increased patient safety and clinical care were reported or observed during the course of the project:

- Increased communication and collaboration between NSW Health, HAI group, ICCMU and CEC about ICU safety initiatives
- Increase in staff awareness and commitment to reducing CLAB
- Increase in collaboration between ICU and Microbiology in assessment of CLAB
- Introduction of credential process and standardisation of practice
- Some rural units introduced processes to extend the program outside ICU
- Discussion document regarding use of hats during sterile insertion to negate resistance to the recommended preparation process
- Multiple resources to support appropriate application of surveillance definitions
- Promotion of clinical practice improvement methodology within intensive care by promoting a community of practice.

External Project Evaluation

The Centre for Clinical Governance Research University of New South Wales was contracted to complete an external independent evaluation of the CLAB ICU project. There were seven key recommendations arising from their report.

The purpose of the evaluation was to assess the effectiveness of the project in meeting project deliverables, as set out in the project scope and to address the following questions.

- What can the project tell us about using guidelines to change clinician behaviour and team processes?
- What strategies were effective in supporting implementation of the central line insertion guideline?
- What strategies were effective in defusing resistance to change?
- What strategies would have improved implementation of the CLAB ICU project aims?
- Has the project increased accountability for CLAB and preventative measures?
- What lessons can be drawn from CLAB ICU about future initiatives implemented by the Clinical Excellence Commission in collaboration with ICCMU?
- What can CLAB ICU tell us about the likely sustainability of quality improvement projects which target clinician behaviour?
- What were the characteristics of compliant and non-compliant units?
- Has the project changed clinical practice regarding central line insertion and CLAB detection and reporting?

The seven recommendations related to clinician engagement strategies and project development. The recommendations and CEC responses and subsequent actions are summarised below. The CEC has implemented a project management policy which addresses many of the recommendations and will apply to future projects.

Start the collaborative process with a pilot demonstration project involving a small number of diverse sites

"The whole unit owns the CLAB project" [nurse manager]

The CEC has implemented this recommendation in its planning for the Quality Use of Antibiotics in Intensive Care (QUAIC) project which will start as a pilot at self-nominated intensive care units in late 2010. However pilot demonstration projects will not be appropriate for all projects and the CEC will consider and determine the most suitable methodology and implementation strategies for each project noting this recommendation.

Establish guidelines for what is required to drive local change

There was considerable turnover of staff both within the CEC and within the ICUs. This required constant orientation for new staff. There was difficulty keeping the contact lists

accurate and ensuring high-quality processes remained in place within the units when staff moved on.

The tasks and expectations of the improvement team members will be made more explicit during project orientation, in an attempt to facilitate implementation at a local level and ensure appropriate transfer of knowledge arising from turnover of improvement team staff.

Clarify the incentives of the collaborative

The CLAB ICU project processes were promoted as core business and patient-focussed. Incentives for the project were clearly stated in Area Health Service agreements. Specific funding for the project was provided for the project team at the CEC level. ICU funding from recurrent MRO strategy funding was difficult for ICUs to access. Resolution was attempted by escalating issues to AHS clinical governance units and alerting the Chief Financial Officer, NSW Department of Health (CFO). In correspondence with the CFO, the CEC recommended that future allocation of MRO funding for specific initiatives be made explicit.

Engage participants early-on in the design of the collaborative

"The Collaborative led to more supervision of insertion of central lines" [intensivist]

The formative phase of the project was guided by an expert group comprised of senior nursing and medical intensive care physicians. Clinicians were widely consulted and involved in the formative phase of the collaborative. However, on reflection, the early consultation was specifically targeted at senior clinicians. It is important to engage clinicians from all hospitals, across all relevant specialities and from the broad spectrum of experience. In future projects, pockets of expertise across NSW will be explored and utilised in project design.

Further, it is proposed that direct appointments of known experts in a field to a CEC expert group will be supplemented by an expression of interest process, to expand opportunities for all interested clinicians to contribute to quality and safety initiatives operated by the CEC.

Allow for local adaptation of tools

"We created an online record of lines inserted for medical staff to keep a record of their insertions" [ICU consultant]

The primary tool used for the project was an insertion checklist. The CEC project team modified the checklist, in response to specific requests from ICUs, when the core elements of the recommended procedure were not jeopardised. In future, the CEC has noted the need for project teams to develop and circulate formal variation processes, in conjunction with a project tool, during the early stages of project implementation.

Use an external auditor to audit the data collection process

There was some scepticism among ICUs about the standard application of the CLAB definition across all ICUs. Many ICUs were unfamiliar with the CLAB ICU surveillance definition and initially over-reported CLAB. The central project team used many

strategies to improve the integrity of the data on reported CLABs, including an online reporting system which requires units to verify the incident of CLAB meets the definition and then provides an opportunity for the central project team to verify the appropriateness of the report. The continuing promotion of optimal blood culture collection and continuing education about the CLAB ICU surveillance definition should improve the consistency of the process of detecting and designating a reportable CLAB.

Build evaluation into the collaborative efforts from the beginning

The recently implemented a results-based model for project conception, management and evaluation at the CEC ensures that the efficiency and effectiveness of a project in meeting its defined activities, outputs and outcomes can be regularly assessed.

Conclusions

The project has reduced CLAB in intensive care. The principles have informed policy which may apply hospital and statewide. The developed tools were designed with sustainability in mind (i.e. to maintain aseptic insertion practice through training, policy and record management). The project highlighted that, although ICUs are clearly committed to providing excellent care to patients, there was a lack of formal quality improvement and audit processes within most ICUs.

The reduction in CLAB in NSW has been sustained. Although there are limitations to the generalisation of the data, information submitted to the online system indicates that the ICU CLAB rate, based on current NSW Health indicator definition and reporting requirements, remains low at approximately 1.0/1000 line days.

Compliance with aseptic technique measured with a checklist has been demonstrated to reduce CLAB rates during this project. The subsequent development of an insertion record and policy will serve to support ongoing process measures to improve central line insertion. To close the feedback loop ICU CLAB data should be provided contemporaneously to ICUs in order to facilitate local improvement measures when required and congratulate successes with sustained improvement.

Recommendations

Hospital-wide roll-out

The CLAB ICU project was focussed on central lines inserted within the intensive care unit. While work has started to generalise and apply the principles beyond the ICU, implementation of such a roll-out did not fall within the original ambit of the project.

Data submitted via the online collection and reporting system since the project's end supports the extension of the project ideals to other departments within the hospital. Data collected from nearly all participating ICUs, after the project, suggests that 47 per cent of reported ICU CLABs are associated with lines inserted in departments other than the ICU such as the emergency department and operating theatre.

To facilitate improvement in central line insertion practices across the hospital it is recommended that the following tools be made available to all staff working in NSW Health to apply hospital and statewide where central lines are inserted:

- The central line insertion record (CLIR)
- The central line insertion guideline adapted to a policy document
- The central line insertion training framework and online training module

Online data system

The online data collection and reporting system was introduced in July 2009, to support ongoing reporting of the ICU CLAB indicator to ICUs in a clinically relevant timeframe.

The data collected through the system has identified an issue with the appropriateness of reporting. To date, 26 per cent of CLABs reported to the system do not meet the surveillance definition. The rate remains below the rate reported by NSW Health highlighting an ongoing dilemma with the application of the surveillance definition.

The ability of the system to collect specific details of the CLAB event, including method of detection and the isolated micro-organism/s and to prompt internal review processes by reporting departments, makes this feature a recommended inclusion in any future strategy to manage and minimise CLAB. It is therefore recommended that:

- Data collection and verification be a shared responsibility between the ICU and other specialties such as infection control with the support of microbiology and infectious diseases specialists
- Education be provided to all staff applying the surveillance definition
- A business case be prepared by NSW Health to support ongoing application of the online database

Resources

The CEC website houses the tools to the CLAB ICU project at the following link: http://www.cec.health.nsw.gov.au/programs/clab-icu.html

References

- Bendall, J. (2007) Progress report - ICU central line bloodstream infections. NSW Health.
- Berenholtz, S. et al. (2004) Eliminating catheter-related bloodstream infections in the intensive care unit. Critical Care Medicine, 32(10): p. 2014-20.
- CEC website (2008) http://www.cec.health.nsw.gov.au/programs/clab-icu.html.
- Collignon, P. (2007) Intravascular catheter bloodstream infections: an effective and sustained hospital-wide prevention program over 8 years. Medical Journal Australia, 187 (10): p. 551-554.
- Intensive Care Coordination and Monitoring Unit, Central Venous Catheter (public pages) Version 1.1. (June 2004, Reviewed January 2008).
- Laupland, K. B. et al. (2004) Intensive-care-unit-acquired bloodstream infections in a regional critically ill population. Journal of Hospital Infection, 58(2): p. 137-45.
- NSW Health, (2005) Infection Control Program Quality Monitoring Indicators.
- NSW Health, (2008) Healthcare Associated Infection: Clinical Indicator Manual Version 2.0.
- O'Grady, N. et al. (2002) Guidelines for the prevention of intravascular catheter-related infections. Recomm Rep, 51: p. 1–29.
- Pronovost, P. et al. (2006) An intervention to decrease catheter-related bloodstream infections in the ICU. New England Journal of Medicine, 355(26): p. 2725-32.
- QLD Government, (2007) CHRISP percutaneous central venous catheter recommended practices version 1 latest version available from: http://www.health.qld.gov.au/chrisp/icare/etoolkit_1.asp.
- Rolls, K. et al. (2008) Building a state-wide knowledge network for clinicians in intensive care units: Knowledge brokering and the NSW Intensive Care Coordination and Monitoring Unit. Australian Critical Care, 21: p. 29-37.
- Rosenthal, K. (2008) Targeting never events. Nursing Management, p. 35.
- Shreve, J. et al. (2010) The economic measurement of medical errors, sponsored by the Society of Actuaries. Milliman. p. 21.
- Zack, J. (2008) Zeroing in on zero tolerance for central line-associated bacteremia. American Journal of Infection Control, 36(10): p. S176.e1-2.

Appendix 1 Expenditure

	2008 $	2009 $	2010 $
Salary and wages			
Salary and wages*	187,297	156,815	
Learning sessions and workshops			
Orientation session	22,975		
Learning session	19,893		
Workshop and seminar costs	3,108	641	
Promotion			
Project branding	4,900		
Posters	461	1649	
Site visits			
Accommodation	625		
Flights	4,119		
Cab charges	284	537	
Reimbursements		141	
Information technology			
Hardware	438		
Software	3,085		
Teleconferences to March 09**	9,482	6,087	
External consultancy	6,387	2,872	
Online reporting system		19,480	
Information technology			
E-learning package		29,000	
Training	1,280		
External evaluation			
External evaluation			27,273
Total annual expenditure GST excl.	264,335	217,223	27,273
Total cumulative expenditure GST excl.			508,831

* Salary and wages of $46 825 were incurred by the CEC during the planning phase of the project in 2006/2007

** Teleconference costs for April - June 2009 were $646.80

Appendix 2 CEC Project Team

Director

Annette Pantle Director CPI CEC Mar 2007 – Sep 2008
Tony Burrell Director Patient Safety CEC Sep 2008 – Completion

Coordinator

Melanie McKinnon Mar 2007 – Jul 2007
Dana Mowaud Jul – Oct 2007
Margherita Murgo Oct 2007 – Feb 2009 (leave: Feb 2009 – Completion)

Officer

Eda Calabria September 2007– Completion

Clinical Lead

Tony Burrell Director ICCMU

Appendix 3 Working Policy History

Document	Version	Document development	Date
Working Policy for the Safe Insertion of Central Venous Catheters in NSW Intensive Care Units (Working Policy)	1	• CHRISP Percutaneous Central Venous Catheter Recommended Practices • Centers for Disease Control and Prevention. Guidelines for the Prevention of Intravascular Catheter-Related Infections. *MMWR*, 2002; 51 (no. RR-10): 1-26. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5110a1.htm • epic2 National Evidence-Based Guidelines for Preventing Healthcare-Associated Infections in NHS Hospitals in England, 2007. http://www.epic.tvu.ac.uk/	May 2007
Working Policy	2-8	Revised based on discussions at 16, 24 and 30 May 2007 expert group meetings	May 2007
Working Policy	9	Circulated at 4 June 2007 orientation session and revised, based on discussion at 15 June 2007 expert group meeting	June 2007
Working Policy	10-11	Revised, based on discussion at 7 December 2007, 1 February 2008 expert group meeting, 27 February 2008 CLAB ICU education and training workshop and 7 March 2008 expert group meeting	Feb 2008
Central Venous Catheter Insertion Policy Statement	1	Revised, based on discussion at 2 May 2008 expert group meeting	May 2008
Draft Infection Control Policy Statement: Central Line Insertion and Post-Insertion Care	New draft	Revised based on discussion at 1 September and 10 November 2009 Central Venous Catheter Policy Working Party	Sep - Nov 2009
Infection Control Policy Statement: Central Line Insertion and Post-Insertion Care	1.0	Approved by Central Venous Catheter Policy Working Party for submission to NSW Department of Health	Nov 2009
Draft Guidelines for central Line Insertion and Post-Insertion Care	Draft	Modified for use, released as draft on the ICCMU and CEC websites	Mar 2010

Appendix 4 Internal Evaluation

Figures 6 and 7 and tables 2–5 illustrate some of the internal evaluation processes. Evaluation indicates consistent participation by ICUs and committee members throughout the project.

Figure 6: NUMBER OF ICUs SUBMITTING DATA BY MONTH

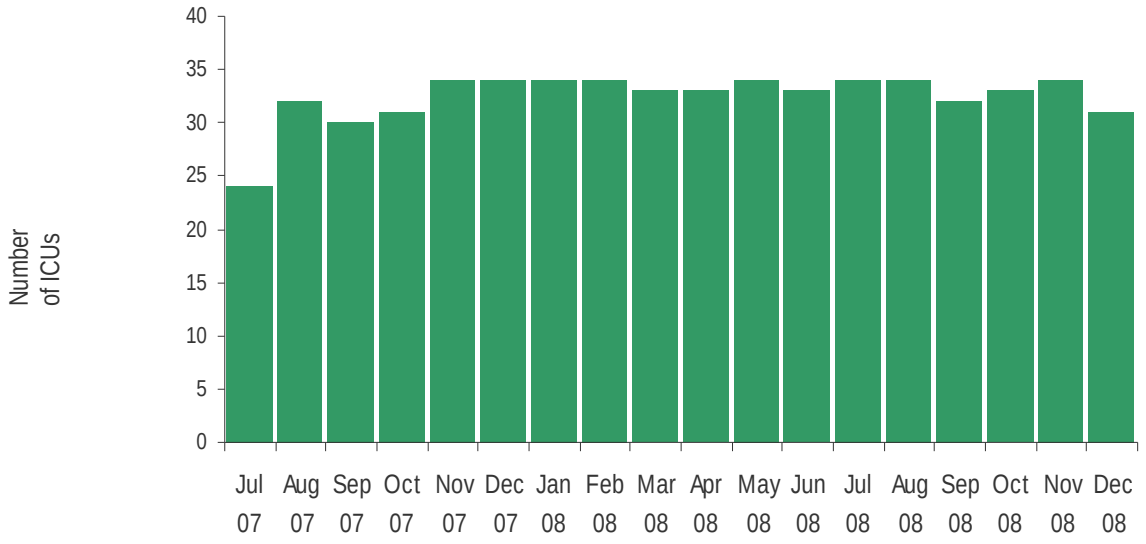


Figure 7: NUMBER OF CHECKLISTS SUBMITTED BY UNNAMED ICU BY MONTH

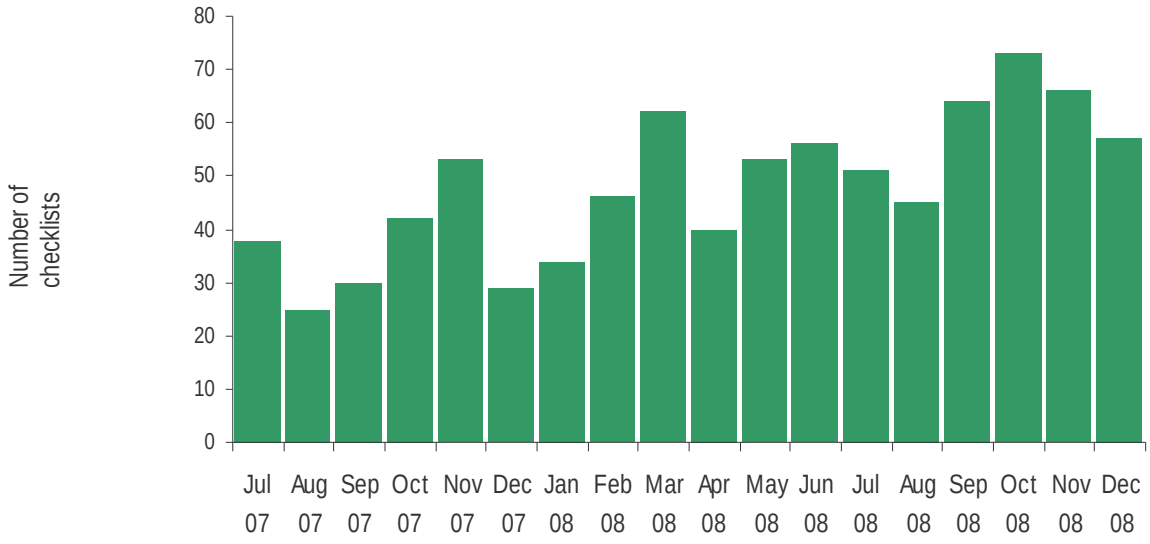


Table 2: STEERING COMMITTEE MEMBERSHIP AND PARTICIPATION

Name	Organisation/Specialty	2007	2008	2009
Prof Clifford Hughes (chair)	CEC	5/7	2/10	0/3
Dr Tony Burrell	ICCMU	7/7	9/10	3/3
Brendan Docherty or alt	Area Health Service	3/7	3/10	1/3
Dr Robert Herkes	NSW Intensive Care Taskforce	5/7	6/10	1/3
Dr Jon Iredell	Infectious Diseases / Microbiology	1/7	1/10	0/3
Dr Nigel Lyons (discontinued August 2008)	Area Health Service CEO	1/7	0/10	–
Wendy Manning or alt	NSW Health	4/7	4/10	2/3
A/Prof Mary-Louise McLaws	Epidemiologist	5/7	7/10	3/3
Margherita Murgo or alt	CEC project co-ordinator	6/7	10/10	3/3
Dr Annette Pantle	CEC	7/7	5/10	1/3
Sue-Anne Redmond or alt	Director of Clinical Governance	4/7	9/10	1/3
Dr Barry Rigby	ICU clinician	2/7	1/10	0/3
Dr David Schell	ICU clinician (paediatrics)	4/7	7/10	2/3
Linda Williams	NSW Intensive Care Taskforce	5/7	7/10	3/3

Table 3: EXPERT GROUP MEMBERSHIP AND PARTICIPATION

Expert Group Membership and Participation				
Name	Organisation/Specialty	2007	2008	2009
Angela Berry (joined March 2008)	ICU CNC	–	2/7	2/5
Dr Tony Burrell (chair)	ICCMU	14/15	7/8	4/5
Hailey Carpen (joined August 2007)	ICU CNC	3/6	7/8	5/5
Dr Anthony Delaney (resigned June 2008)	ICU clinician	4/15	1/4	–
Dr Robert Herkes	NSW Intensive Care Taskforce	10/15	4/8	0/5
Dr Jon Iredell	Infectious Diseases / Microbiology	3/15	1/8	0/5
Dr Sean Kelly	ICU Clinical Network Director	12/15	3/8	0/5
Dr John Lambert	ICU clinician	7/15	4/8	3/5
A/Prof Mary-Louise McLaws	Epidemiologist	11/15	6/8	3/5
Wendy Manning or alt	NSW Health	11/15	3/8	0/5

Expert Group Membership and Participation				
Name	Organisation/Specialty	2007	2008	2009
Project Co-ordinator	CEC	15/15	8/8	5/5
Dr Michael O'Leary or alt (discontinued August 2008)	ICU clinician	3/15	0/5	–
Dr Annette Pantle	CEC	12/15	4/8	0/5
Dr Michael Parr	ICU clinician	8/15	1/8	2/5
Dr Peter Saul (discontinued August 2008)		0/15	0/8	–
Dr Theresa Jacques (discontinued 2008)	ICU clinician	2/15	–	–
Dr John Ferguson (Joined September 2008)	Micro/ID	–	2/2	1/5
Roger Duve (joined August 2008)	Clinical governance	–	2/3	2/5
Dr Ross Calcroft (discontinued 2007)	ICU clinician	1/15	–	–
Louise Morgan (joined October 2007)	International student placement	4/4	–	–

Table 4: ATTENDANCE TO PROJECT TELECONFERENCES BY PROFESSIONAL GROUP AND MONTH

Monthly Teleconference Attendance 2007–2009				
Meeting date	Number of doctors	Number of nurses	Number of others	Total participating ICUs
2007				
July	6	12	1	13
August	11	20	4	24
September	5	26	3	22
October	6	11	4	18
November	6	18	4	17
December	4	17	2	17
2008				
January	2	16	3	16
February	5	21	5	21

Monthly Teleconference Attendance 2007–2009				
Meeting date	Number of doctors	Number of nurses	Number of others	Total participating ICUs
March	8	17	3	23
April	6	23	2	18
May	5	22	4	23
June	8	20	2	19
Aug/Sep	7	18	3	17
Oct/Nov	5	22	3	18
Dec/Jan	4	17	2	17
2009				
Feb/Mar	5	21	1	19
Apr/May	4	16	2	15
June	5	8		7

Table 5: ATTENDANCE TO PROJECT TELECONFERENCES BY PROFESSIONAL GROUP AND MONTH

Monthly Teleconference Attendance 2007– 2008				
Meeting date	Number of doctors	Number of nurses	Number of others	Total participating ICUs
Aug/Sep	7	18	3	17
Oct/Nov	5	22	3	18
Dec/Jan	4	17	2	17
Feb/Mar	5	21	1	19
Apr/May	4	16	2	15
June	5	8		7

Appendix 5 Overview of IIMS Data

Central Line Incidents

Severity Assessment Code	Incident	July 07 – March 08
1	Retained guidewire	3
2	Retained guidewire	5 *
3	Retained guidewire	5 **
3	Broken guidewire	2
4	Retained guidewire	-***

* One incident was associated with a femoral arterial line insertion, which is a similar procedure.

**** One of the SAC 3 incidents required surgical removal of a retained guidewire and may have warranted classification as a SAC 2 event.

*** Given the volume of incidents and methodology of review, SAC 4 incidents were stratified and a representative percentage of the July 07 – March 08 incidents reviewed. No further guidewire issues were identified in that subset.

PICC Line Incidents

The additional keyword “PICC” was added to a later search. The results are noted below.

Severity Assessment Code	Incident	July 07 – March 08
1	Retained guidewire	0
2	Retained guidewire	0
3	Broken guidewire	1
4	Retained guidewire	-***

Appendix 6 Project Presentations

Year	Author/Presenter	Title	Forum	Comments
2010	M Murgo, AR Burrell, E Calabria on behalf of the CLAB ICU Collaborative	The evaluation of a collaborative approach to enabling clinicians to change practices for central line insertion and reduce bacteraemias	The inaugural Australasian Clinical Networks Conference	Oral presentation
2010	AR Burrell, M-L McLaws, A Pantle, M Murgo, E Calabria, R Herkes	The NSW Central Line Associated Bacteraemia – ICU Project	World Health Organisation, Geneva	Oral presentation
2009	AR Burrell, A Pantle, M Murgo, E Calabria	Standardising training requirements for central line insertion across NSW, Australia	International Forum on Quality and Safety in Health Care	Poster presentation Third prize
2009	AR Burrell, M-L McLaws, A Pantle, M Murgo, E Calabria	The NSW Central Line Associated Bacteraemia –ICU project	ANZICS Annual Scientific Meeting Perth	Baxter prize for best safety and quality presentation
2009	AR Burrell, M-L McLaws, A Pantle, M Murgo, E Calabria	The NSW Central Line Associated Bacteraemia –ICU project	Safety Quality Audit and Outcomes Conference Queenstown	Oral presentation
2008	AR Burrell	Reducing central line associated bacteraemias through a standard approach to insertion practice	Safety Quality Audit and Outcomes Conference Christchurch	Oral presentation
2008	M Murgo, A Pantle, AR Burrell, E Calabria	Standardising training requirements for central line insertion across New South Wales	Australasian Association for Quality in Health Care Christchurch	Poster presentation
2008	A Pantle	Reducing cental line associated bacteraemias through a standard approach to insertion practice	Australasian Association for Quality in Health Care Christchurch	Oral presentation
2008	R Herkes	Reducing central line associated bacteraemias through a standard approach to insertion practice	The Rural Special Interest Group Uluru	Oral presentation
2007	A Pantle and S Kelly	Training Framework for junior clinicians new to inserting central lines in NSW	IMET Forum	Oral presentation

ICCMU
Intensive Care Coordination & Monitoring Unit

NSW HEALTH

CLINICAL EXCELLENCE COMMISSION