



Bankstown-Lidcombe Hospital

Medical Gases Incident:

Final Report

Prepared by the Chief Health Officer

26 August 2016

1. Purpose

This Report has been prepared by the Chief Health Officer to update the NSW Minister for Health in relation to critical incidents that occurred at Bankstown-Lidcombe Hospital in June and July 2016: dispensing incorrect gas to two neonates through a neonatal resuscitator in Operating Theatre 8. Specifically, this Report has been informed by:

- *Expert Report: Theatre 8 Medical Gas Cross Connection Bankstown-Lidcombe Hospital (17 August 2016)* - prepared by Stuart Clifton, engaged by NSW Health as an expert engineer
- Root Cause Analysis (RCA) investigation report
- Correspondence from BOC Limited (Ltd.)
- Status advice on the disciplinary proceedings

2. Introduction

Bankstown-Lidcombe Hospital (part of South Western Sydney Local Health District [SWSLHD]) is a principal referral group A1 hospital with tertiary affiliations to the University of NSW, University of Sydney and University of Western Sydney. It provides a wide range of general medical and surgical services and some sub-specialty services to communities in Bankstown-Canterbury Local Government Area (LGA). Clinical services in the Hospital are mainly at role delineation level 5.

It provides clinical services in: emergency medicine; cardiology; surgical sub-specialties including general, ENT, colorectal, peripheral neurosurgery, ophthalmology, orthopaedics, plastics, upper gastrointestinal pancreatic and biliary, vascular, breast and urology; medical sub-specialties including general medicine, endocrinology, gastroenterology, infectious diseases, neurology, neurophysiology, renal medicine, respiratory and rheumatology; cancer therapy including medical and surgical oncology, chemotherapy and haematology; intensive care unit/high dependency unit; maternity, gynaecology, special care nursery and paediatrics; mental health; drug health; rehabilitation and aged care; and imaging.

In relation to maternity services, Bankstown-Lidcombe Hospital has 10 neonatal cribs in the special care nursery and six birthing unit suites, which are supported by eight operating theatres.

On average 2,220 babies are born each year at Bankstown-Lidcombe Hospital.

3. Background / Summary of Events

In January 2014, a baby who required resuscitation was delivered in the birthing unit at Bankstown-Lidcombe Hospital. During the resuscitation the oxygen cylinder emptied and staff transferred the baby to the special care nursery across the corridor to ensure ongoing oxygen supply for the resuscitation.

Following a Root Cause Analysis (RCA) investigation into the circumstances surrounding the care provided, the Hospital installed piped oxygen outlets in the birthing unit that provided a constant oxygen supply for the resuscitaires in the birthing unit.

The decision was subsequently made to install piped oxygen to the neonatal resuscitaires in the operating theatres. The approval for work to proceed was given by the General Manager on 10 June 2015.

Bankstown-Lidcombe Hospital engaged BOC Ltd. to install, test and commission piped oxygen for the resuscitaires in Operating Theatres 1-8. Fire officer documentation obtained by the disciplinary investigation team indicates that the BOC Ltd. contractor attended to the work over two nights, 14 and 15 July, and the work was completed on 16 July 2015.

While Operating Theatre 8 continued to be used, there was no cause for the newly installed gas outlet to be used until late June 2016 when Baby 1 was born and required resuscitation following delivery. The baby survived, with an unexpected poor outcome. An investigation through the RCA process was commenced to understand the reasons for the unexpected poor outcome.

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On 13 July 2016, Baby 2 was born in the same operating theatre. Baby 2 required resuscitation and died. This incident was referred for a mandatory patient RCA.

The unexpected death of Baby 2 was notified to the Coroner on 13 July 2016, with the senior paediatrician advising Baby 2's family that this was required under the law. Later that day, in response to the referral, police from Bankstown Police Station attended the Hospital to conduct inquiries.

Another paediatrician involved in the clinical review of the cases requested testing of the gas outlets in Operating Theatre 8 on 14 July 2016 to understand whether this could have in any way contributed to the unexpected outcome. A work order for this testing was put in place. The gas outlet was not required to be used from 14 July 2016.

The oxygen outlet was tested by BOC Ltd. and subsequently by Hoslab on 21 July 2016 and was found to be emitting nitrous oxide instead of oxygen. Operating Theatre 8 was closed from this date until it was rectified on Thursday 18 August 2016 in a process that was compliant with the relevant Australian Standard.

On 21 July, in order to ensure that no other babies had been exposed to nitrous oxide, Surginet (a theatre booking system) was interrogated and cross checked against the birth register and medical records. It indicated 36 patients had given birth in Operating Theatre 8. A full review of the clinical records was completed on the morning of 22 July 2016. This showed the neonatal resuscitaire in Operating Theatre 8 was used on two neonates (Baby 1 and Baby 2).

SWSLHD arranged for the testing of all gas outlets in operating theatres and birthing units in all hospitals across SWSLHD, commencing on 21 July and completed on 26 July. This testing was subsequently extended to all gas outlets across SWSLHD.

A range of investigations were commenced to identify the cause of this catastrophic error and identify lessons to prevent a recurrence, and immediate action was taken to confirm this was an isolated, albeit catastrophic, error (refer to Section 6: NSW Health system response).

The investigations instigated by NSW Health include:

1. Independently chaired Root Cause Analysis (RCA) investigation

A decision to commence an RCA in relation to Baby 1 was made on 23 June 2016. Baby 2's death was referred to a mandatory RCA on 13 July 2016. However, due to the critical information in relation to the error with the gas outlet being discovered, a new RCA covering the cases of Babies 1 and 2 was initiated on Monday 25 July.

The RCA team was led by Professor Michael Nicholl, Clinical Director, Division of Women's, Children's and Family Health, Northern Sydney Local Health District. Membership of the RCA team is listed at Appendix H.

The RCA investigation included a review of the antenatal and intra-partum care, resuscitation of both neonates and the processes for medical gas piping installation and commissioning that occurred in the operating theatres in July 2015.

The parents of Baby 1 and Baby 2 will be provided with the aspects of the RCA that pertain to them and their baby as well as a common section covering the incorrect installation and commissioning of the medical gases to the neonatal resuscitaire in Operating Theatre 8.

2. Independent expert engineer's report

The 'Expert Report: Theatre 8 Medical Gas Cross Connection Bankstown-Lidcombe Hospital (17 August 2016)' was prepared by Stuart Clifton, who was engaged by NSW Health as an expert engineer.

3. Disciplinary investigation

Following the suspension of an engineer involved in signing the commissioning test form as a witness, a formal disciplinary process was commenced. This has involved initial interviews with those directly involved in the events surrounding the installation and commissioning to identify individual accountability. Fourteen staff have been interviewed and having regard to the information obtained to date, a further 13 interviews are planned, including a number of senior managers.

Lawyers for the engineer advised their client would not be participating in the investigation given the pending coronial inquiry.

4. Existing relevant statewide policies

The following relevant statewide policy directives were in force at the time of the installation:

- NSW Health Process of Facility Planning (POFP) Guidelines for Projects Valued less than \$10M (2010), disseminated via Policy Directive 2010_035 (http://www0.health.nsw.gov.au/policies/pd/2010/pdf/PD2010_035.pdf); and
- NSW Health Engineering Services and Sustainable Development Guidelines Technical Series TS11 (Version 2.0 December 2007), disseminated via Guideline 2008_002 (http://www0.health.nsw.gov.au/policies/gl/2008/pdf/GL2008_002.pdf).

The NSW Process of Facility Planning (POFP) provides a robust framework for planning and procuring capital infrastructure across the NSW public health system. The Engineering Services and Sustainable Development Guidelines are intended as a handbook to be used during the briefing and design process and these require compliance with Australian Standard 2896-2011 in relation to the installation of medical gases.

5. Findings of the Root Cause Analysis and expert engineer

The RCA and the independent expert engineer's report identify the flawed installation and subsequent flawed testing and commissioning process as the cause of the administration of nitrous oxide instead of oxygen to Baby 1 and Baby 2.

The reports also raise issues relating to project planning, governance and risk assessment evident at Bankstown-Lidcombe Hospital. The RCA investigation report notes it was unable to locate a number of relevant documents as described under the Local Health District's "Contract Management Procedure" (PCP2015_009) and "Minor

Capital Works Approval” (PD2014_A01.19). A “permit to work” form and a risk assessment and safe work method statement could not be located.

The RCA identified several gaps in Bankstown-Lidcombe Hospital’s and the District’s engineering governance and management processes, as well as a need to clarify and strengthen the relationship between the Local Health District and the Hospital’s engineering services.

An email from the Nurse Unit Manager of perioperative services at Bankstown-Lidcombe Hospital dated 14 July 2015 indicates that the work was planned to be undertaken over two nights (14 and 15 July 2015) with four operating theatres being completed each night. The ‘Engineering Department Permit for Hot Work and Fire Isolations’ form, located by the disciplinary investigation, indicates the BOC Ltd. contractor was issued with permits for two nights – 14-15 and 15-16 July 2015. The BOC Ltd. test certificate form T5 indicates the testing was undertaken on 15 July 2015 (Appendix A).

The relevant Australian Standard that covers this work is *AS2896: Medical gas systems - installations of non-flammable medical gas pipeline systems*. This Standard has been revised and updated a number of times in the past 30 years with the latest release in 2011. The expert engineer notes “this Standard is used in all medical gas installations in Australia”.

The report continues: “The Standard sets out the requirements for the safety aspects, construction, testing and certification, operation and maintenance of non-flammable medical gas pipeline systems used for patient care, therapeutic, diagnostic and for operating surgical tools. Non-flammable medical gas pipeline systems include suction pipeline systems.”

The expert engineer notes that two sections of the Standard are particularly relevant: clause 4.13 and section 5.

Clause 4.13: Connection to existing systems - "Connections to existing systems shall be undertaken in only one gas system at a time to minimise the risk of cross-connection."

This prescribes that only the gas to be cut in is isolated and the local pipe drained of pressure. When the pipe is then cut into to make the new connection there should be no pressurised gas. If pressurised gas is present the installer knows there is an issue with the gas type.

The expert engineer concludes: "It is apparent that all gases including nitrous oxide were isolated during installation. Therefore when the nitrous oxide pipe was cut into there would have been no indication that the wrong pipe was cut."

The original pipework in the Bankstown-Lidcombe Hospital operating theatres was installed as part of the original build of the facility some 20 years ago by Hoslab. The expert engineer observed that the existing ceiling pipework supplying oxygen and nitrous oxide to the medical gas panel in the anaesthetic bay had been mislabelled. The pipework carrying nitrous oxide had been labelled oxygen at the end closest to the Operating Theatre 8 anaesthetic bay while at the other end (approximately 4 metres away) it was correctly labelled nitrous oxide. An identical situation happened with the oxygen pipework with one end incorrectly labelled nitrous oxide and the other end correctly labelled oxygen.

However, if correct procedures were followed at the time of installation in July 2015, when the oxygen supply was turned off at the main medical control panel, and the pressure released, when attempting to cut into the pipeline (wrongly labelled oxygen), the cross connection would have been identified as the pipe being cut (which was actually nitrous oxide) and would have been pressurized at 410KPA.

The expert engineer notes: "I am of the opinion that the incorrect affixing of 2 pipe labels in the original install would have resulted in redundant work by BOC but due to the other checks at the time of installation and commissioning that BOC were required

to undertake, the mislabelling of the pipework would have had no bearing on the cross connection as relying on the pipe label only would have caused them to cut the wrong pipe.”

Section 5 Testing and Certification - the expert engineer indicates this section of the Australian Standard sets out the procedures for certifying a medical gas installation that, if followed, would make it impossible for the system not to operate safely.

Extract from AS 2896-2011

5.7 Certification of systems

5.7.1 Operational test

Prior to the commissioning of a medical gas system, testing by a designated person shall be performed to determine that the concentration of the medical gas is correct and that there is no contamination. A member of the health care facility experienced in the administration of medical gases to patients and such other persons as are required by the administration of the health care facility, shall be present and witness the tests. Where non-respirable medical gases, e.g. nitrous oxide and carbon dioxide are piped, tests shall be performed by the anaesthetist-in-charge or a delegated anaesthetist. If any gas is supplied at more than one pressure, testing shall be performed with only one pipeline pressurized on each occasion.

The process for testing for gas purity (see Appendix A: BOC Test Certificate Form T5, part 12) is the ultimate test to ensure that the right gas comes out of the right outlets. The results recorded on the Medical Gas Outlet Test Form (Appendix B) are incorrect as confirmed by Hoslab on 21 July 2016 (Appendix C). The expert engineer notes the recorded value of 100% for the oxygen outlet would not be possible when using an oxygen analyser as no oxygen was present, hence a value close to 0% should have been recorded. He also notes that looking at the Medical Gas Outlet Test Form (Appendix B)

for Operating Theatre 8 it appears that the outlet purity was measured twice with 100% recorded in both instances.

Investigations to date indicate that no clinical staff were involved in the witness testing. Based on the information available to me, the Head of the Anaesthetics Department at Bankstown-Lidcombe Hospital was unaware of the installation work being undertaken at that time.

6. NSW Health system response

On 21 July 2016, the Ministry of Health was notified of the incident and convened a teleconference to establish the key facts and support the statewide and local response to the incident.

On the morning of 22 July, all Local Health Districts and Specialty Health Networks were instructed to provide advice in relation to the following:

1. What is the process to verify that the gases coming from medical gas outlets on the wall are correct at commissioning and if there are any changes to the gas supply?
2. Are clinicians involved in this process and how?
3. How frequently are gas outlets checked?

At 2pm on 22 July the Clinical Excellence Commission (CEC) held a teleconference with Local Health Districts and Specialty Health Networks to confirm the nature of the request, timelines for response, and address any issues requiring clarification. Appendix E identifies the responses to these questions. Later on 22 July, an assurance was sought from Local Health Districts and Specialty Health Networks that the identified processes were adhered to.

Responses from Local Health Districts and Speciality Health Networks indicated the outlet commissioning processes they have in place complied with Australian Standard 2896-2011 with the exception of Far West Local Health District. Systems are now in place in Far West Local Health District to ensure future witness testing for

commissioning of new outlets includes a member of the health care facility with experience in the administration of medical gases to patients or anaesthetist where required.

Issues associated with incorrect piping of gases (such as nitrous oxide being emitted instead of oxygen) have clinically significant impacts. The risk assessment identified this to be a very low risk of occurrence but potentially having catastrophic consequences. This particular error can occur where nitrous oxide and oxygen are both piped, such as in operating theatres, and occurs when there is an error in both the installation and the subsequent testing process. The CEC reviewed the Incident Information Management System to search for any incidents of this nature and found none.

On Monday 25 July 2016, Local Health Districts and Specialty Health Networks were instructed to undertake testing (i.e. analysis of gas type) of any recently commissioned units or where pipe work had been undertaken (e.g. operating theatres, critical care, emergency departments and maternity) in the last 24 months, particularly focusing on areas where the gas outlets may not have been used or used infrequently. This advice was requested to be provided within 24 hours.

Late on Monday 25 July, the scope was extended to all new works or refurbishments within the last five years and this was followed up with additional correspondence on Tuesday 26 July. Appendix F provides a report in relation to this work.

On 29 July, in order to provide further assurance, the Minister directed testing of all gas outlets in NSW Health facilities be undertaken. The Health Secretary wrote to all Chief Executives of Local Health Districts and Specialty Health Networks to:

1. Test, using a gas analyser, each medical gas outlet installed within any facility (new build or upgrade) within the last five years to confirm the gas type and concentration. The testing was to include air and oxygen medical gas outlets whether co-located with other gases or not. Advice confirming that the testing had occurred and the outcome of that testing was to be provided to the Chief Health Officer by close of business Monday 1 August 2016.

2. Test, using a gas analyser, all other medical gas outlets in NSW Health facilities to confirm the gas type and concentration. The testing was to include air and oxygen medical gas outlets whether co-located with other gases or not.

Advice confirming the testing had occurred and the outcome of that testing was to be provided to the Chief Health Officer by close of business Monday 15 August 2016.

Appendix G confirms that testing of all medical gas outlets in use is complete and no issues of incorrect piping of gases were identified.

Health Infrastructure confirmed that for capital works in NSW Health facilities managed by Health Infrastructure, a three-step process for commissioning is undertaken. Step 1, the subcontractor to the principal contractor confirms the installation is compliant with the design. Step 2, the principal contractor will confirm to NSW Health representatives that the system is ready to be tested and Step 3, the certification process occurs in accordance with Australian Standard 2896-2011.

NSW Health has drawn on advice from a CEC expert group to advise on whether additional statewide policy or protocols on medical gas installation should be considered.

7. Conclusion

Both babies required resuscitation following their birth and the administration of nitrous oxide instead of oxygen prevented effective resuscitations. The death of Baby 2 has been referred to the Coroner who will determine the cause and manner of death.

The incorrect installation of the pipes and subsequent flawed testing and commissioning process, which should have detected the installation error, led to the babies being resuscitated with nitrous oxide instead of oxygen. The processes followed did not comply with Australian Standard 2896-2011. Both BOC Ltd. and South Western

Sydney Local Health District staff have responsibilities in this regard which, in my view, were not met.

Both the RCA and expert engineer's report raise broader issues about the project planning and risk management of the commissioning of clinical infrastructure at Bankstown-Lidcombe Hospital and the governance, both clinical and corporate, thereof. Robust governance processes for the commissioning of clinical infrastructure provide an essential safeguard against the risks arising from individual error.


8. Recommendations

1. In light of the issues identified by the RCA and independent expert engineer's report, a review of senior management's role in relation to the broader governance (both clinical and corporate) of the commissioning of clinical infrastructure at Bankstown-Lidcombe Hospital is to be undertaken by the Ministry of Health.
2. Oversight of the current disciplinary investigation is to transfer from the Local Health District to the Ministry of Health.
3. The Ministry of Health is to promulgate a standard set of requirements for the engagement of contractors which includes the requirement for contractors to have a separation of the installer and the tester.
4. The Ministry of Health is to write to Australian Standards suggesting it consider whether Australian Standard 2896-2011 requires clarification in relation to the situations in which the presence of an anaesthetist is required and consider an additional requirement to separate the installer and the tester.
5. The Ministry of Health accepts the RCA recommendation in regard to a submission to the Australian Resuscitation Council requesting review of the existing algorithm and flowchart to include a process during unexpected hypoxia for checking and changing the gas supply and circuits, including a final step of isolation of the neonate from the circuit and gas supply and changing to a self-inflating bag using room air only.


6. South Western Sydney Local Health District is to be put on performance watch, under the NSW Health performance framework, and monitored for the purpose of ensuring the RCA recommendations and any other recommendations arising are implemented.

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Appendix A – BOC Ltd. test certificate form T5

 A Member of The Linde Group	AS 2896		
Test Certificate - Form T5			
Part 11 - Tests for Compressed Air Purity Part 12 - Tests for Gas Purity			
Project: <u>Bankstown Theatres 1-8</u>	Date: <u>15-7-15</u>		
Contract Ref.:	Job No.: <u>70085931</u>		
Area Tested: <u>Theatres 1-8</u>			
Part 11 - Tests for Purity of Compressed Medical Breathing Air (Refer Clause 2.9)			
Test method:	<input type="checkbox"/> A sample of compressed medical breathing air was taken and tested in accordance with AS2568.		
Test results:	<input type="checkbox"/> The requirements of Clause 2.9 have been met.		
These test procedures have been carried out in accordance with the requirements of Australian Standards AS2896. All Zone Contaminant Tests satisfactory.			
Tested by:	Installer signature Name print		
Witnessed by:	Client's Officer signature Name print		
Part 12 - Test for Gas Purity (Refer Clause 5.6.5)			
Gases Tested:			
<input checked="" type="checkbox"/> Oxygen	<input type="checkbox"/> Nitrous Oxide	<input checked="" type="checkbox"/> Breathing Air	<input type="checkbox"/> Surgical Tool Gas
<input type="checkbox"/> Nitrous oxide/oxygen 50/50	<input type="checkbox"/> Carbon Dioxide	<input type="checkbox"/> Carbon dioxide in oxygen-nominal 5%	
<input type="checkbox"/> Other (state gas) _____			
Test Pressure			
<input checked="" type="checkbox"/> a) Medical Gas Pressure Systems	(415kPa)		
<input checked="" type="checkbox"/> b) Vacuum Systems	(-60kPa)		
<input type="checkbox"/> c) Surgical Tool Gas Systems	(1400kPa)		
Test method:	<input checked="" type="checkbox"/> With all systems simultaneously at test pressures above, all zone isolation valves were opened. Ensured that all systems are complete and not linked. All gas supply sources to the pipeline system were connected and the gas identity at every terminal units was verified.		
Test results:	<input checked="" type="checkbox"/> The requirements of Clause 5.6.5 have been met.		
These test procedures have been carried out in accordance with the requirements of Australian Standards AS2896. All Medical Gas Purity and Identification Tests satisfactory.			
Tested by:	Installer signature Name print		
Witnessed by:	Client's Officer signature Name print		
Certificate Distribution			
1. Client's Permanent Record.	2. Contractor's Project File.	3. Installer's Project File.	
PAD0121680C_0310			

Appendix B - BOC Ltd. medical gas outlet test form



BOC Limited
A.B.N. 95 000 029 729


Medical Gas Outlet Test Form

Hospital: Banks-town Theatres. Page: 2 of 2

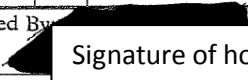
Test Date: 15-7-15 Job No.: 70085931

Area/Ward	Room No.	Outlet Type	Static Pressure (kPa)	Dynamic Pressure (kPa)	Pressure Drop (kPa)	Flow Rate (L/min)	Oxygen Concentration	Pass	Comments	Released
Theatre 6	6	oxy	410	405	5	40	100	✓		✓
"	"	oxy	410	370	40	250	100	✓		✓
"	"	Air	420	415	5	40	21	✓		✓
"	"	Air	420	380	40	250	21	✓		✓
"	"	Vac	-80			100	100	✓		✓
Theatre 7	7	oxy	410	405	5	40	100	✓		✓
"	"	oxy	410	370	40	250	100	✓		✓
"	"	Air	420	415	5	40	21	✓		✓
"	"	Air	420	380	40	250	21	✓		✓
"	"	Vac	-80			100		✓		✓
Theatre 8	8	oxy	410	405	5	40	100	✓		✓
"	"	oxy	410	370	40	250	100	✓		✓
"	"	Air	420	415	5	40	21	✓		✓
"	"	Air	420	380	40	250	21	✓		✓
"	"	Vac	-80			100		✓		✓

NOTE: Findings for Operating Theatre 8 not consistent with Hoslab test results from 21 July 2016

Inspected By: 

Print: Signature of BOC Ltd. representative

Witnessed By: 

Print: Signature of hospital engineer

PAD01223

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Appendix C - Service report sheet from Hoslab regarding Operating Theatre 8 testing

	Hoslab Pty Ltd PO Box 825, Ryde, NSW 1680 Telephone: (02) 9816 3555 Fax: (02) 9816 3888 Email: service@hoslab.com.au	ABN : 43 612 857 315
	Ref No. 2752 Date 21/7/16	
SERVICE REPORT SHEET		
Client: BANKSTOWN HOSPITAL Address: ELDRIDGE RD 		Time In: 11:30 Time Out: Travelling:
Details of work carried out		
TESTING OF EXISTING NEO NATAL RESUS PANELS IN THEATRES		
THEATRE 1 OXYGEN = 100% MEDICAL AIR = 20.9%	THEATRE 5 OXYGEN = 100% MEDICAL AIR = 20.9%	
THEATRE 2 OXYGEN = 100% MEDICAL AIR = 21%	THEATRE 6 OXYGEN = 100% MEDICAL AIR = 21%	
THEATRE 3 OXYGEN = 100% MEDICAL AIR = 20.9%	THEATRE 7 OXYGEN = 100% MEDICAL AIR = 21%	
THEATRE 4 OXYGEN = 100% MEDICAL AIR = 20.9%	THEATRE 8 OXYGEN = 0% MEDICAL AIR = 20.9%	
THEATRE 8 - NITROUS OXIDE VALVEBOX WAS ISOLATED AND CONFIRMATION THAT N2O WAS COMING OUT OF OXYGEN OUTLET IN THEATRE 8.		
Materials used		
Signature [Redacted] / [Redacted]	Signature [Redacted] / [Redacted]	
Block letters [Redacted] / [Redacted]	Block letters [Redacted] / [Redacted]	
Client or Agent	Serviceman	

Appendix D – Timeline of events relating to the medical gas incident

Date	Event
Late June 2016	Attempted resuscitation of Baby 1 using wall-outlet labelled “oxygen” in Operating Theatre 8. First time outlet has been used since installation. Baby transferred to high-level facility for care.
23 June 2016	Decision for a RCA investigation into the circumstances around Baby 1’s birth and care.
13 July 2016	Attempted resuscitation of Baby 2 using wall-outlet labelled oxygen in Operating Theatre 8. Resuscitation attempt unsuccessful. Death reported to the Coroner, family informed by senior paediatrician of the referral. NSW Police attended Bankstown-Lidcombe Hospital after the referral to the Coroner.
14 July 2016	Paediatrician requests check of gas outlet used for neonatal resuscitations; engineering work order issued as paediatrician was interested in exploring any possible contribution to the unexpected poor outcome. The gas outlet in Operating Theatre 8 neonatal resuscitaire was not required to be used in the period until Operating Theatre 8 was closed.
21 July 2016	Gas outlet in Operating Theatre 8 neonatal resuscitaire tested by both BOC Ltd. and Hoslab and found to be emitting nitrous oxide instead of oxygen. Operating Theatre 8 was closed. Testing of all gas outlets in operating theatres and birthing units across South Western Sydney Local Health District commenced (concluded 26 July 2016). Ministry of Health and Clinical Excellence Commission notified. Process for Open Disclosure commenced.
22 July 2016	Contact made with the families to notify them of the facts surrounding the two births through an open disclosure process. Open disclosure occurred with family of Baby 1 at 6pm. Family of Baby 1 requested privacy. An appointment was made with Family of Baby 2 for the following day. General Counsel NSW Health writes to BOC Limited seeking urgent advice. Chief Executive SWSLHD writes to the State Coroner informing him of information relating to gas outlets not known when the initial report is made.
23 July 2016	Family of Baby 2 open disclosure meeting held at 3pm.
25 July 2016	BOC Ltd. advises NSW Health that it is conducting an investigation. Visit to site by NSW Police (on behalf of the State Coroner).
26 July 2016	Media conference conducted by Minister for Health and Health Secretary. Follow up site visit by Police.
27 July 2016	Site inspection by BOC and LHD. Follow up visit by Police and their expert engineer.
28 July 2016	Further site visit by BOC, LHD and Police.
29 July 2016	First meeting of independently chaired RCA investigation team.

Appendix E – Response to questions regarding gas outlet commissioning processes (excluding SWS LHD)

LHD	Verification Process	Frequency of check (pressure/flow)
St Vincent's	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
SCHN	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Central Coast	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Far West	Has been verified by two independent gas technicians and a LHD technician with specific medical gas training. Process in place to ensure future verification complies with AS2896-2011, through the inclusion of a clinician.	Outlets checked six monthly, i.e. more frequently than required by AS2896-2011
Hunter New England	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Illawarra Shoalhaven	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Mid North Coast	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Murrumbidgee	Verified according to the AS2896-2011.	Outlets checked six monthly, i.e. more frequently than required by AS2896-2011
Nepean Blue Mountains	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Northern NSW	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Northern Sydney	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
SES	Verified according to the AS2896-2011.	Outlets checked at least annually (some as often as monthly), exceeding the requirements of AS2896-2011
Southern NSW	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Sydney	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Western NSW	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Western Sydney	Verified according to the AS2896-2011.	Outlets checked as per AS2896-2011
Justice Health & Forensic Mental Health	Verified according to the AS2896-2011. [One outlet is not in use and is being considered for decommissioning.]	New outlet will be checked as per AS2896-2011

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Appendix F – Checking of newly-commissioned gas outlets for gas type (within past 5 years)

LHD	Sites where re-testing complete	Sites remaining to be re-tested	Expected completion date/Status
SCHN	Sydney Children's Hospital, Randwick The Children's Hospital at Westmead	Nil	Complete No issues identified
Southern NSW	South East Regional Hospital (Bega) Yass Hospital Moruya Hospital Goulburn Hospital Batemans Bay	Nil	Complete No issues identified
CCLHD	Gosford Hospital Wyong Hospital Woy Woy Hospital Long Jetty Hospital	Nil	Complete No issues identified
SLHD	Canterbury Hospital Royal Prince Alfred Hospital Concord Hospital	Nil	Complete No issues identified
NBMLHD	Blue Mountains Day Procedure Centre Nepean Hospital	Nil	Complete No issues identified
WSLHD	Auburn Hospital Westmead Hospital Blacktown Hospital Mt Druiitt Hospital	Nil	Complete No issues identified
ISLHD	Shoalhaven Hospital Shellharbour Hospital Wollongong Hospital Bulli Hospital	Nil	Complete No issues identified
HNELHD	John Hunter Hospital Tamworth Hospital Narrabri Hospital Scott Memorial Hospital - Scone Glen Innes Hospital Manilla Hospital Singleton Hospital Armidale Hospital Cessnock Hospital Inverell Hospital Muswellbrook Hospital Gunnedah Hospital	Nil	Complete No issues identified
FWLHD	Broken Hill Health Service	Nil	Complete No issues identified
MNCLHD	Bellingen River District Hospital Wauchope District Hospital Coffs Harbour Health Campus Port Macquarie Base Hospital Kempsey District Hospital Macksville District Hospital	Nil	Complete No issues identified
SWSLHD	Liverpool Hospital Campbelltown Hospital Fairfield Hospital Bowral Hospital Bankstown-Lidcombe Hospital	Nil	Complete No issues identified

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LHD	Sites where re-testing complete	Sites remaining to be re-tested	Expected completion date/Status
	(Camden – N/A no works in the last 5 years)		
NNSWLHD	Byron Hospital Murwillumbah Hospital Health One Pottsville Tweed Hospital Ballina Hospital Casino Hospital Lismore Base Hospital Maclean District Hospital Yamba Community Health Grafton Base Hospital	Nil	Complete No issues identified
NSLHD	Manly Hospital Mona Vale Hospital Ryde Hospital Hornsby Ku-ring-gai Hospital Royal North Shore Hospital	Nil	Complete No issues identified
SESLHD	Prince of Wales Hospital Sydney & Sydney Eye Hospital The Sutherland Hospital Royal Women's Hospital St George Hospital	Nil	Complete No issues identified
WNSWLHD	Dubbo Base Hospital Forbes District Hospital Parkes District Hospital Gulgong Health Service Peak Hill Health Service Eugowra Health Service Bathurst Health Service Walgett Health Service Cowra District Hospital Orange Health Service	Nil	Complete No issues identified
Sydney LHD	Canterbury Hospital Concord Hospital Royal Prince Alfred Hospital Chris O'Brien Lifehouse Sydney Dental Hospital	Nil	Complete No issues identified
Murrumbidgee LHD	Tumut Hospital Gundagai District Hospital Corowa District Hospital Young Hospital Deniliquin Hospital Hillston District Hospital Lockhart District Hospital Griffith Hospital Coolamon Hospital Temora Hospital Wagga Wagga Rural Referral Hospital	Nil	Complete No issues identified
St Vincent's Health Network	St Vincent's Hospital	Nil	Complete No issues identified
JH&FMH	N/A at the time of request	N/A	N/A

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LHD	Sites where re-testing complete	Sites remaining to be re-tested	Expected completion date/Status
Network			
ASNSW	N/A - no piped gas	N/A	N/A

Appendix G – Checking of all NSW Health facility gas outlets for gas type and concentration

	Confirmation of testing
LOCAL HEALTH DISTRICTS	
Central Coast LHD	Complete No issues identified
Far West LHD	Complete No issues identified
Hunter New England LHD	Complete No issues identified
Illawarra Shoalhaven LHD	Complete No issues identified
Mid North Coast LHD	Complete No issues identified
Murrumbidgee LHD	Complete No issues identified
Nepean Blue Mountains LHD	Complete No issues identified
Northern NSW LHD	Complete No issues identified
Northern Sydney LHD	Complete No issues identified
South East Sydney LHD	Complete No issues identified
South Western Sydney LHD	Complete No further issues identified
Southern NSW LHD	Complete No issues identified
Sydney LHD	Complete No issues identified
Western NSW LHD	Completed No issues identified
Western Sydney LHD	Completed No issues identified
SPECIALITY HEALTH NETWORK	
Sydney Children’s Hospitals Network	Complete No issues identified*
ASNSW	N/A - No piped gases
Justice Health & Forensic Mental Health Network	Complete** No issues identified
NSW Health Pathology	Complete No issues identified
St Vincent’s Health Network	Complete No issues identified
Cancer Institute	No gas outlets

*During the course of testing for gas type and concentration, an instance of gas outlet panel mislabelling was identified and corrected; this did not present a risk to patient safety.

**One outlet is not currently operational and is being considered for decommissioning. For this reason, it was not tested.

Appendix H – Membership of the Root Cause Analysis investigation team

Chair: Professor Michael Nicholl, Clinical Director, Division of Women's, Children's and Family Health, Northern Sydney Local Health District

Members:

- Senior Anaesthetist (external to LHD and supported by the Royal Australian and New Zealand College of Anaesthetists)
- Neonatologist (external to LHD)
- Senior Paediatrician & Clinical Director (SWSLHD)
- Nurse Manager Operating Theatres (SWSLHD)
- Clinical Midwifery Consultant (SWSLHD)
- Patient Safety Manager (SWSLHD)
- Patient Safety Manager (Clinical Excellence Commission)
- Director, Clinical Governance(SWSLHD)
- Manager, Capital Works (SWSLHD)
- Engineer (external to LHD)
- Engineer (independent to NSW Health)