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ORIGINAL PAPER

Business continuity in blood services: two case studies from events with potentially catastrophic effect on the national provision of blood components

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Vox Sanguinis

Background and Objectives NHS Blood and Transplant (NHSBT) and the Australian Red Cross Blood Service (ARCBS) are national blood establishments providing blood components to England and North Wales, and Australia, respectively. In 2012, both services experienced potentially catastrophic challenges to key assets. NHSBT suffered a flood that closed the largest blood-manufacturing centre in Europe, whilst ARCBS experienced the failure of a data centre network switch that rendered the national blood management system inaccessible for 42 h. This paper describes both crisis events, including the immediate actions, recovery procedures and lessons learned.

Materials and Methods Both incidents triggered emergency response plans. These included hospital reprovisioning and recovery from the incident. Once normal services had been restored, both events were subjected to root cause analysis (RCA) and production of 'lessons learned' reports.

Results In both scenarios, the key enablers of rapid recovery were established emergency plans, clear leadership and the support of a flexible workforce. Product issues to hospitals were unaffected, and there were no abnormal trends in hospital complaints. RCA identified the importance of risk mitigations that require co-operation with external organizations. Reviews of both events identified opportunities to enhance business resilience through prior identification of external risks and improvements to contingency plans, for example by implementing mass messaging to staff and other stakeholders.

Conclusions Blood establishment emergency plans tend to focus on responding to mass casualty events. However, consolidation of manufacturing to fewer sites combined with a reliance on national IT systems increases the impact of loss of function. Blood services should develop business continuity plans which include prevention of such losses, and the maintenance of services and disaster recovery.

Key words: blood supply, business continuity, crisis management, emergency, incident management, risk assessment, supply chain, systems outage.

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Introduction

Blood services across the world are increasingly organized on a national basis, in line with World Health Organisation recommendations. Consistent with this strategy and in response to falling demand for red cells and economic pressures, provision of manufacturing, testing and specialist services has been consolidated onto fewer sites in many countries. In addition, IT is now an integral part of blood component testing and manufacturing, with a single system potentially controlling national blood stocks. Consequently, more attention is being paid to resilience and disaster recovery.

In UK and Australia, incident management is facilitated by a national approach, which aims to improve resilience through consistent practices across sites, allowing transfer of manufacturing activity and finished stock between them. NHSBT's business continuity management system (BCMS) is based on British Standard BS25999 [1] which requires that products and services which support the organization's objectives, obligations and statutory duties are identified. Activities critical to supporting these key products and services [2] are highlighted, and analyses of business functions performed to highlight risks and potential mitigations. Risks may be addressed by a resilience measure (e.g. a generator, or additional stocks), or by a planned response in the event of disruption. NHSBT's plans are based on a maximum tolerable period of disruption (MTPoD) of 24 h at any site, taking account of customer, statutory and regulatory requirements.

Australian Red Cross Blood Service (ARCBS's) Emergency and Business Continuity Management Framework is designed to expedite the resumption of business activities after disruption of critical operations. The principal objectives are to minimize disruption of service to customers, patients and donors, ensure timely resumption of operations, and minimize impact to reputation.

In extreme situations, however, even well-designed incident management systems are severely tested. This paper describes two potentially catastrophic events that occurred during 2012 and discusses the responses to those events and the lessons learned.

Case study 1: Flooding of Filton manufacturing site, NHS Blood and Transplant, UK

Background

NHSBT is an integral part of the National Health Service. It is the sole supplier of blood components and diagnostic services to hospitals in UK and North Wales, and retrieves and allocates organs for transplantation for the whole UK. At the time of the flood in September 2012, NHSBT comprised five manufacturing and three testing sites, and 15 stock-holding units (SHUs), which provide stock within 2 h to every hospital. The Filton Blood Centre, which has a footprint of 9200 m^2 and total area (both floors) of 17 400 m^2, was opened in 2008 after a 2-year build programme. Following the consolidation of activity in South and West England, Filton accounted for 43% of national red cell production (Table 1) and 41% of all components produced. Filton also tested 45% of donations collected by NHSBT in 2012 – this figure has since risen to 63% (January 2014).

Filton also houses a number of specialist services unique to this site, including the National Cord Blood Bank, the British Bone Marrow Registry and the International Blood Group Reference Laboratory (IBGRL), a WHO collaborative centre. Other Filton-based services include Red Cell Immunohaematology, Histocompatibility and Immunogenetics, Stem Cells and Immunotherapies and Research Laboratories.

The incident

At 9 am on Monday 24 September 2012, following heavy rainfall, floodwater entered the building submerging the manufacturing hall under 20 cm of water within 20 min, and other areas of the building between 5 and 20 cm as the Filton site is on a gentle slope. An hour later, all power, data services and telephony had been

Table 1 Manufacturing activity data, Australian Red Cross Blood Service (ARCBS) and NHSBT, 2012–2013

2012–2013	ARCBS National	NHSBT National	NHSBT Filton	% Filton
Whole blood donations collected	1 322 813	1 895 333	809 147	42·7
Red cells produced	824 073	1 859 255	794 902	42·7
Platelet pools produced	84 650	42 763	15 899	37·2
Component donation platelets produced	56 880	253 265	82 527	32·6
FFP units produced	175 218	245 112	104 346	42·5
Cryoprecipitate units produced	81 305	163 986	50 407	30·7
Staff whole-time equivalents (WTEs)	3200	5068	600	11·8

lost, resulting in the loss of refrigeration, environmental monitoring, air handling and building management systems.

Initial response (day 0)

A chronology of events on the day of the incident is summarized in Table 2.

NHSBT's command and control plan was activated at 9·45 am. These arrangements include local and national managers on-call 24/7, with local incidents managed by a critical incident manager (CIM) supported by a local emergency team (LET). The CIM can escalate incidents to a national critical incident manager (NCIM) who may seek support from a national emergency team (NET); there is always an Executive Director on-call.

In this incident, the Filton LET was formed immediately, the NCIM informed, and a NET formed including the on-call National Executive Director with responsibility for emergency situations, and the senior manager with accountability for Filton operations. LETs were formed at all other sites around the country in readiness to receive products from Filton. The director took overall strategic command.

An initial assessment made by a senior fire officer suggested that the building should be evacuated and would be out of use for several weeks. NHSBT's response was to ensure the safety of staff, maintain continuity of services to hospitals by reproviding services elsewhere and transfer blood stocks to other locations. All 12 000 products on site were transferred to other blood centres within 6 h of flooding and collections rerouted to alternative sites. Surface temperatures were monitored regularly with thermometers to ensure that products remained within approved temperature limits.

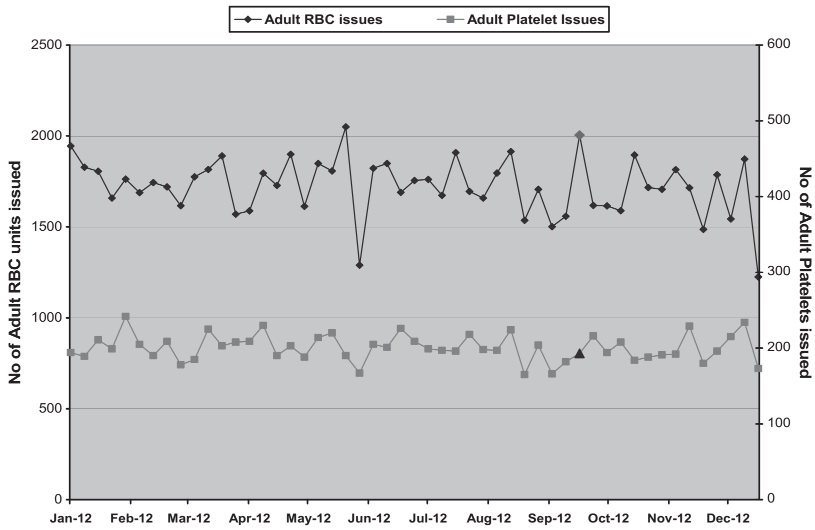
The communications plan was activated to advise hospitals served by Filton of alternative provision and delivery schedules. Additional communications to other hospitals allowed them to understand the impact of the event on services. As a result of the prompt actions taken, NHSBT filled every hospital order placed that day without any modification or delay. Figure 1 identifies that product issues to hospitals were not materially affected, and Fig. 2 highlights that there were no abnormal trends in hospital complaints.

Reprovisioning and recovery

The following day, recovery and reprovisioning of services was initiated. A detailed logistics plan was developed to deal with rerouting of blood collections, whilst ensuring that donations remained within controlled temperatures. Services to Filton's hospitals continued to

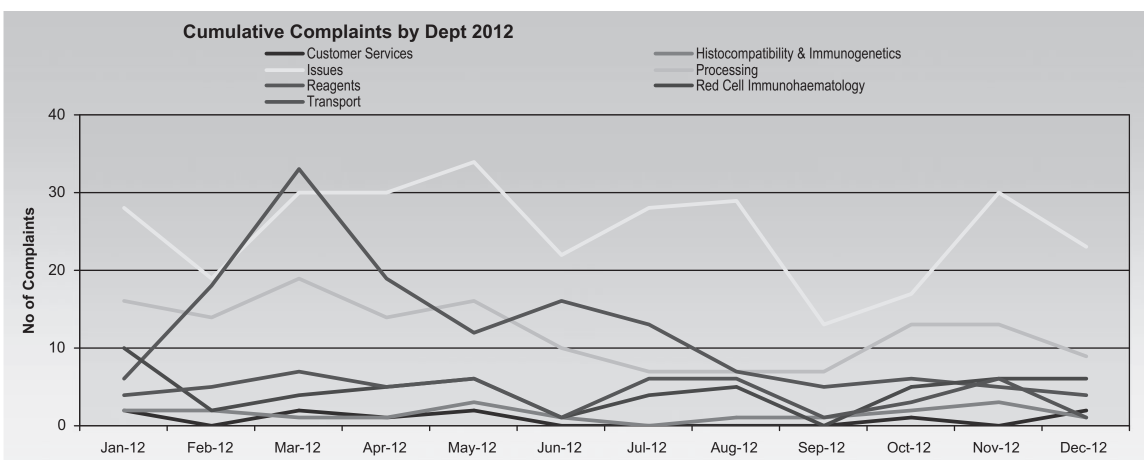
Table 2 Chronology of events on the day of the NHSBT Filton Blood Centre flood

08:00	• Water discovered at door to hospital services department • Field behind the blood centre flooded. Sandbags were put in place.
08:30 – 09:00	• Car park flooded. • Flood water entered hospital services department Avon Fire and Rescue service was called, and arrived on site. Management prioritized protecting cold rooms and lifting equipment off the floor.
09:00 – 09:45	• Water flooded building at 9:00 am. • By 9:20am, ground floor flooded in *up to 20 cm* of water. • Cold rooms flooded. Staff on the ground floor lifted everything off the floor where possible. Senior operations manager (on holiday in France) informed of situation.
09:45 – 10:00	LET meeting held – command and control plans implemented. Avon Fire and Rescue advised that the building needed to be evacuated.
10:00	Non-essential staff asked to leave.
10:10	Power to the centre was turned off, resulting in loss of refrigeration, environmental monitoring, air handling and building management systems.
10:10 – 11:30	*Bulk movement vehicles (BMVs) were brought in to provide alternative refrigerated space to the Filton cold rooms* Additional BMVs **were** ordered from Birmingham and Southampton. Customer Services phoned hospitals to advise the situation, for example no fulfilment of emergency orders from Filton. Fire brigade monitored toxicology and water levels. Component packing for evacuation commenced.
11:30 – 12:00	NET Meeting held *Fire brigade sourced a high-performance pump.*
12:10	Evacuation of 5040 validated red cells commenced.
12:30	Evacuation of freezers commenced, 1600 FFP and 600 pooled cryo.
12:30 – 15:00	Evacuation of 150 non-bacterial tested platelets, 5400 invalidated red cells and 135 bacterial tested platelets.
15:00	By 15:00, all components and staff evacuated from building. NET Meeting held in local ambulance station, used as the HQ
16:30 – 20:30	• Water level starts to recede. Power supplies for the ground floor isolated, enabling restoration of power to first floor laboratories (19:15). First floor laboratories inspected to record cold store temperatures. Temporary power supply established to the SCI Lab, to enable topping up of liquid nitrogen vats.



Source: Elaine MacRate, NHSBT. UK Blood Stocks Management Scheme

Fig. 1 Product issues to hospitals served by the Filton Blood Centre in 2012.



Source: Elaine MacRate, NHSBT. UK Blood Stocks Management Scheme

Fig. 2 Cumulative complaints by NHSBT department in 2012.

be provided by other centres, and some processes were changed by medical concession allowing testing laboratories at other sites to focus on mandatory testing:

(1) CMV antibody testing was reduced to a minimum in line with guidance from the UK Safety Advisory Committee on Blood, Tissues and Organs (SaBTO) [3].
(2) West Nile Virus, malaria and T. cruzi testing for travellers returning from endemic areas was suspended.
(3) Bacterial screening of platelets was suspended, and the platelet shelf life reverted from 7 to 5 days.

Ongoing communications with hospitals included information on the issuing of CMV-negative components and the conversion of platelets to 5-day shelf life.

The recovery team set clear targets for the reoccupation of departments, and access to the building was controlled. Staff sent home when the flood occurred were advised when to return to work using messages on the staff helpline which were refreshed regularly (Table 3).

Cleaning the ground floor was key, and advice was obtained from NHSBT's Director of Infection Prevention and Control and the joint NHSBT/Health Protection Agency microbiology team. Requalification of equipment was required before reuse. Following cleaning, environmental monitoring samples were taken from all affected GMP areas.

Filton operations were halted on the morning of day 0. Power was returned to parts of the building later on day 0 and IT services at the end of day 1. The first department to reoccupy the workspace was IBGRL (on the first floor) at the end of day 2 followed by other first floor departments in the following 2 days. By day 4, full GMP

Table 3 Chronology of events for reoccupation of the NHSBT Filton Blood Centre

25 September (day 1)	Message placed on hotline to update staff on the situation. First floor power was inspected. Clean-up operation commenced. Broken router was fixed to provide first floor with IT access.
26 September	• IBGRL returned to the building. • IT fully functional.Deep cleaning and disinfectant cleaning began. Carpets removed from ground floor, and dehumidifiers installed. Power returned to 80% of building, and circuit by circuit testing commenced.
27 September	• Building access control reinstated. • Telephone system reinstated. • BBMR and H&I departments returned to the building. • Environmental monitoring commenced
28 September	• GMP procedures resumed in manufacturing and hospital services.Electrical safety testing of all equipment commenced. Electrical tests and engineering reviews conducted in testing.
1 October	• MHRA visit. • Sessions from Filton, Oxford and Plymouth returned to Filton. • RCI department returned to Filton. • Testing, manufacturing and hospital services staff returned to the centre for evening shifts.
2 October	• Manufacturing resumed operations for the South West and Tooting • Hospital services operations returned to full operations overnight. Stock build preparations were implemented.
3 October	• Carpets were replaced and all rooms declared operationally by 08.10.13.

The table describes the chronology of events for the reoccupation of the Filton Blood Centre.

systems had been established in the manufacturing and testing areas.

Throughout this process, the regulator, Medicines and Healthcare Products Regulatory Agency (MHRA), was kept fully informed. On day 7, MHRA visited the site and agreed that manufacture of blood components could resume. They inspected the facility 2 weeks later to assure regulatory compliance.

Approximately one-third of available collections were returned to Filton on the night of day 7 for manufacture and testing, followed by the full complement of collections on the following night. Arrangements for reprovisioning and alternative supply to hospitals were withdrawn over the following days as stock was built within Filton.

Root cause analysis (RCA)

Analysis of the incident revealed a confluence of factors; the incident followed an unusually wet summer and a ‘1 in 30 year’ storm occurred on 23/24 September 2012. Water should have been drained adequately by a culvert to the rear of the site, owned and managed by another organization. However, the culvert had partially collapsed, and the pumps that had been installed proved inadequate to deal with the amount of floodwater.

The collapse of the culvert, and the inadequate performance of the pumps, was the root cause of the flooding. Given that the management of the culvert was the responsibility of another organization, more detailed analysis of the root cause proved impossible.

Lessons learned

The lessons learned exercise identified 34 key items for improvement, including the following:

(1) Changes to the command and control procedure.
(2) Review of national reprovisioning plans.
(3) Review of the number of people involved in NET and LET meetings.
(4) Change in the training of fire marshals and wardens.
(5) Create a mass messaging facility to improve staff communications.
(6) Improve communications with staff-side representatives.

In addition, NHSBT reviewed its conduct of site-specific risk assessments. A new joint approach has been rolled out across all sites, with a review of external threats and risks. Despite the mistakes that occurred in the run-up to the flooding incident, the effective recovery process led to NHSBT being awarded the *Business Continuity Institute European Region Award*.

Case study 2: Failure of the National Blood Management Computer System, Australian Red Cross Blood Service

Background

ARCBS is a division of the Australian Red Cross Society and the sole supplier of blood products, tissue typing and related services to hospitals across Australia. ARCBS operates four main processing and testing facilities, and 83 static collection sites and 37 mobile teams in 2000 locations in metropolitan and regional areas. ARCBS employs 3880 staff and 2400 volunteers, who serve 600 000 donors in the provision of 1·3 million donations annually.

Table 1 provides details of annual product supply across Australia.

The incident

On 4 July 2012 at 4·00 am, ARCBS experienced failures in network switches in the National Blood Management System (NBMS) production data centre, causing the NBMS application to become inaccessible. Operations continued using manual contingency procedures for 42 h before transition to the disaster recovery (DR) system at 9·40 pm on 5 July. The DR system provided a stable environment to continue operations, though with reduced performance capability. Consequently, operational activities had to be intensively supervised to manage system load.

The event was different from previous NBMS outages. The unprecedented duration of the event was caused by the complexity of linkages between a variety of components within the NBMS infrastructure. A failure in one component triggered subsequent failures, which prevented switching to the backup production data centre, as presented in Fig. 3. The major incident affected operations over 2 weeks whilst the system was restored. Return of services to the production system from the DR system was successfully executed, and normal daily operations recommenced on 23 July.

Staff and management maintained business continuity during the initial 42-hr outage period and subsequent 12-hr period using manual contingency procedures (see Table 4).

ARCBS' business continuity plan was invoked as soon as the nationwide system outage occurred. The National Emergency Management Committee (NEMC) was convened to supervise and prioritize critical business activities in each region. Regional Emergency Management Committees (REMCs) managed local operations. Communications from NEMC to each REMC were continuous and bidirectional with authority designated to the co-ordinator who oversaw decision-making and communications between the committee. Manual contingency procedures were activated, with business activity restricted to critical functions required to support continuity of supply. Manual control systems ensured that the quality of the blood supply was maintained.

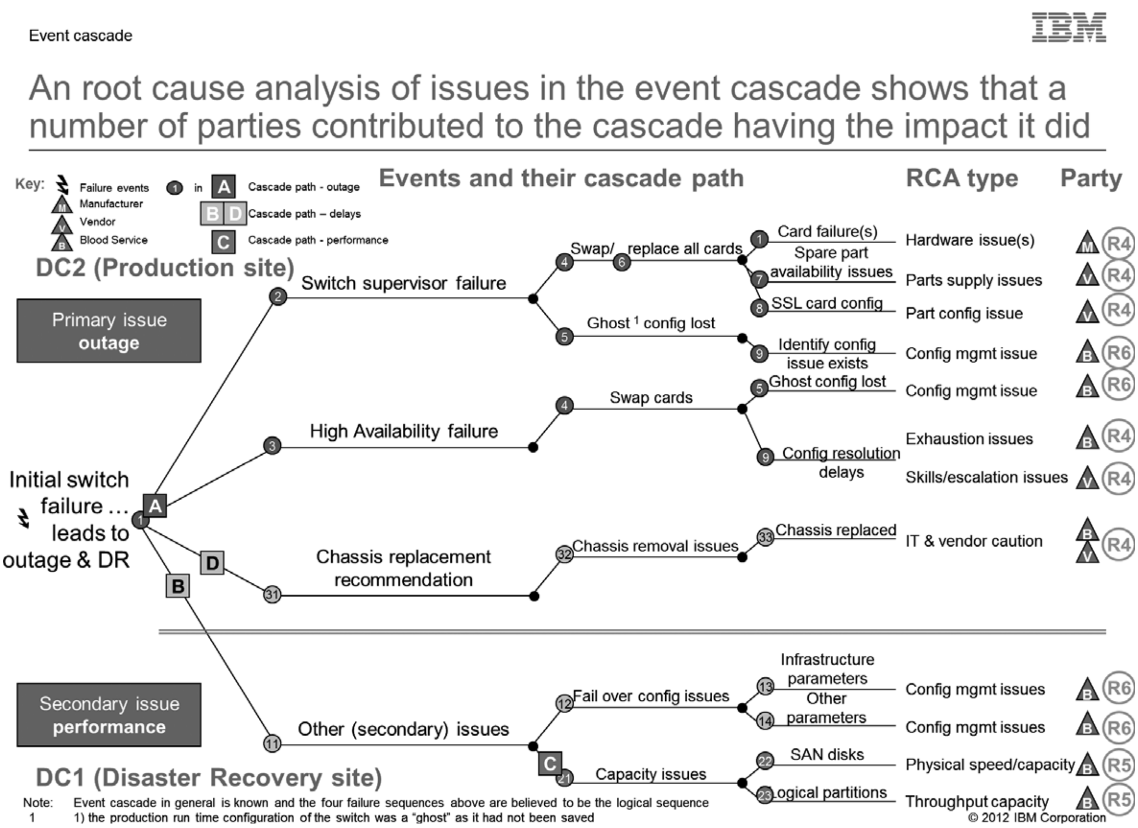


Fig. 3 Australian Red Cross Blood Service, National Blood Management System failure event cascade. This figure illustrates the cascade of system problems that manifested after the initial switch failure (A). The subsequent system component failures following the initial switch failure followed four different paths of varying severity over the period of 4th to 20th July The primary root causes identified were capacity and capability of technical resources (R4), processing capacity within the disaster recovery site (R5) and configuration management, documentation and knowledge management (R6).

Table 4 Australian Red Cross Blood Service summary of National Blood Management System (NBMS) outage events

Dates (2012)	NBMS outage periods	Duration, h
4th–5th July	Major outage incident causing loss of NBMS	42
6th July	NBMS memory shortage outage	1
15th July	NBMS tuning restart	1
21st–22nd July	DR->PROD Fail back process	12

In parallel, critical ARCBS IS resources, external contractors and vendors commenced RCA and system restoration. Initially, IS recovery forecasts were overly optimistic, and key milestones were missed. As the IS contract had not been called on in such a situation previously, shortfalls resulting in a shortage of spare parts and long response times were not anticipated. Consequently, the decision to move business activity to the DR system was delayed.

The National Blood Authority (NBA), the body responsible for the provision of an effective blood service across Australia, and the Therapeutic Goods Administration (TGA), the national regulator, were advised of the situation, as were customers. Communications to each of these stakeholders were channelled through single points of contact.

Recovery

All available technical expertise was initially deployed in restoring the production system. Three solution options were progressed in parallel as follows:

(1) *Option 1* – repair of the switch, followed by resumption of services on the existing hardware system (chassis). Initial forecasts estimated that NBMS would be online within 3 h, but the solution also presented the highest risk.

(2) *Option 2* – configure switch number 2. This had proved unsuccessful on previous attempts, and consequently, the timeline for this resolution was unknown.

(3) *Option 3* – build new IT hardware. This required external contractor expertise and was estimated to be concluded within 6 h, which proved to be optimistic.

Figure 4 provides a summary of the NBMS system recovery.

By day 2, IS prepared to fail over to the DR system as endeavours to restore production continued. Plans were made for staggering user access to the DR system, with collection staff given highest priority. The DR system was made available to users at 9·40 pm on day 2. All non-essential transactions were therefore controlled by the NEMC.

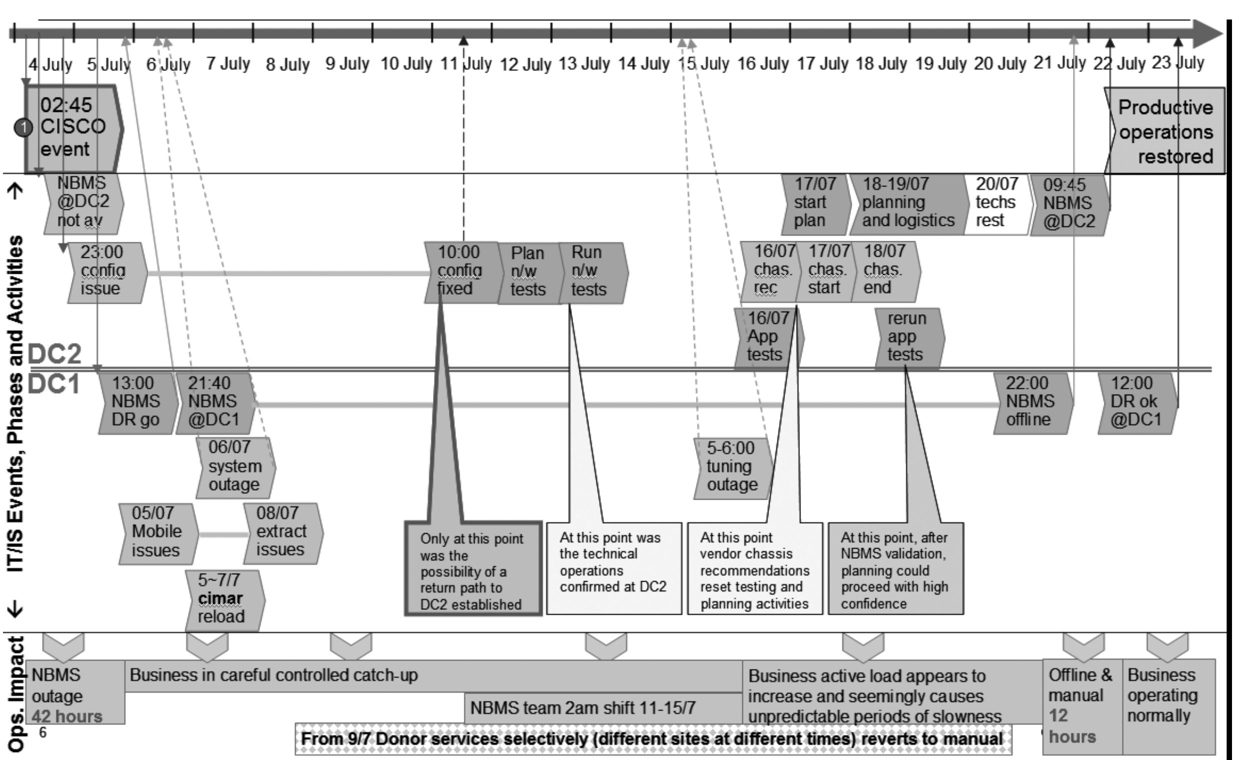


Fig. 4 Australian Red Cross Blood Service, National Blood Management System recovery summary. NBMS (eProgesa); DC1 (data centre 1); DC2 (data centre 2); DR (disaster recovery); CIMAR (reporting system); Config (configuration of failed network switch); n/w tests (network testing); Chas Rec (network switch recovery); App tests (application testing); Techs (technicians).

During days 2 and 3, national platelet inventory was significantly depleted and the magnitude of the clinical impact of the outage varied between regions. Whilst clinical demand could not be fully met, and in a few cases had to be fulfilled with products with incomplete malarial and CMV testing, no products were released that fell below the standards required by statute and guideline.

On day 3, the NBA activated the National Blood Supply Contingency Plan to stage 'White Alert'. The TGA also provided inspectors to review the situation and produce a same-day report. Staff worked extra shifts to maintain the blood supply to hospitals. Processing and testing staff worked a night shift to better balance business activity over the 24-hour day. Staff well-being became a concern as many had been working long hours for an extended period.

By day 9, blood stocks were improving, and the DR environment had stabilized. This provided confidence that the inventory position would continue to improve as the backlog in processing was gradually cleared and the proactive recruiting of platelet donors generated crucial platelet inventory.

As a consequence, the 'White Alert' activated 5 days earlier was lifted by the NBA. Work rosters returned to normal, although staff had to remain vigilant to DR performance limitations and adjust as necessary to minimize impact on critical activities. Throughout the outage period and for much of the following 5 days, there was a lack of up-to-date inventory data. Supply chain teams relied on frequent manual inventory counts to plan each day's production targets. Fail back to the production system was planned and executed on day 17 although it required a planned outage of up to 15 h.

Root cause analysis

Figure 4 provides a diagram of the NBMS failure event cascade.

The outage was triggered by the failure of one component from one manufacturer. The failing component triggered other issues within the manufacturer's device. Those issues were exacerbated by inadequate support (technical, management and spare part availability) from the manufacturer's agent. The failing components highlighted a latent configuration issue in a network switch that may have been introduced during the last stages of the transition from Progesa to eProgesa, when a series of soft fail over tests were conducted on the manufacturer's device. The cause was isolated to a software bug within the switch software which presented as a hardware problem, delaying a correct diagnosis. A lesson learned was that network switch redundancy be improved and tested routinely. For business continuity, it is imperative that the DR system provides adequate performance, so that if the production system fails, available capacity would not be compromised.

Discussion

Blood services play a vital role in the provision of health care, and the failure of a blood service can be catastrophic for the hospitals and patients that it serves. It is incumbent upon blood service leaders to operate best international practices to ensure business continuity when challenged by disruptive events.

Whilst the events described are significantly different, both followed the classic 'Swiss cheese model' [4]. There were multiple defences for both scenarios, but each had limitations which aligned in each case, resulting in catastrophic incidents.

These events also fulfilled Reason's hypothesis that failures often have 'primary origins in a variety of delayed-action human failures committed long before an emergency state could be recognized' [4].

Both services had business continuity plans to manage the types of incidents that were experienced. NHSBT had considered the possibility of a flood at the Filton Blood Centre. Site inspections conducted by the UK Environment Agency had identified damage to the culvert as a potential problem. However, the culvert was not situated on NHSBT property, and a mistake was made in not insisting that the senior management employed by the 3rd-party organization repaired the damage earlier.

This capacity to have plans to meet scenarios that may occur is compatible with the discipline of business continuity, defined as 'a holistic process that identifies potential threats to an organization and the impacts to business operations that those threats, if realized, might cause' [5]. Blood services have a disproportionate impact on health care if they fail, and the stakeholder list is long and includes the patient at its heart. Business continuity has been formalized in standards, the most recent of which sets out to provide a system 'to protect against, reduce the likelihood of occurrence, prepare for, respond to, and recover from disruptive incidents when they arise' [6].

When exposed to these scenarios, both organizations enacted plans that had been derived through their business continuity processes. In both cases, these worked well, with limited impact on hospitals.

As well as responding to the incident, an organization must recover from it and return to business as usual. The International Standard outlines this in section 8.4.5 [6]. Both organizations considered recovery as soon as they understood the need for a large-scale response. In the Australian scenario, recovery centred on repair of NBMS. For NHSBT work started immediately on recovering the Filton site. A recovery group was created, devising an ambitious plan that would see the start of manufacturing and distribution in the early part of the following week, with a full return to business within 2 weeks of the flood. The quality assurance function played a central role in approving return to work for all regulated activity.

There were, as with any disruptive event, a number of lessons learned that were specific to the organizations, assets, events and individuals concerned. For NHSBT, the key improvement to its business continuity approach was greater consideration of physical threats to sites from the surrounding environment, and the need for dialogue with other organizations on whom the integrity of its sites depends. For ARCBS, strengthening the robustness of the organization required improved systems resilience and failover capability, coupled with periodic joint exercises by IS and operations, to rehearse business continuity management activities.

There were also a number of common themes that are consistent with the experience of many who manage response to large-scale disruption. The first such finding is that the response system needs regular review: risks, impacts, plans and individuals need to be regularly tested. In the Australian scenario, the National Blood Contingency Supply Plan had not been updated for 4 years, and in the event it worked well in some areas whilst the need for improvements in other areas was identified. NHSBT had undertaken several major consolidations, and certain procedures had not been updated. This need for constant review is a part of good practice [5] and standards [6], and is found consistently in real-time response [7].

There is a temptation when exercising plans to undertake tabletop exercises as these are less disruptive [8]. These provide opportunities for learning if approached with the correct attitude, but they can lack realism, and in certain events can lead to an over optimistic view of plans. The Australian event led to initially unrealistic expectations due to over optimistic timelines for recovery, and NHSBT found that small items that supported the blood supply chain such as cold boxes did not flow adequately when logistics had been altered to accommodate the site failure.

The necessity of managing staff appropriately, in terms of training and competence before the event, and command, control and welfare during the event was crucial. Competence is essential and along with that proper succession planning for those with roles in disaster response. Importantly, the goodwill of staff and their willingness to 'go the extra mile' was a key success factor in the recovery process in both organizations.

Poor communication is frequently cited in reviews of disruptive events, [9] and communication is cited as one of the core skills of senior managers co-ordinating responses to a crisis [10]. The incidents described suffered their own communication failures: lack of universal adoption, failure in telephony, lack of mass messaging capacity, and failing to communicate with some stakeholders. Both organizations have now planned changes to their communication mechanisms.

NHSBT and ARCBS faced difficult challenges in 2012. The services they provided to their customers were bound to be affected, given the nature of the emergencies. This article attempts to demonstrate that such events can be managed without release of products that fall below the standard required by statute and guideline, through rapid and effective response mechanisms.

Acknowledgements

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References

1. British Standards Institute: *BS25999 - Business continuity management – Part 2: Specification*. London, BSI, 2007
2. British Standards Institute: *BS25999 - Business continuity management – Part 1: Code of practice*. London, BSI, 2006
3. https://www.gov.uk/government/policy-advisory-groups/advisory-committee-on-the-safety-of-blood-tissues-and-organs [Last accessed 28 October 2014]
4. Reason J.: The Contribution of Latent Human Failures to the Breakdown of Complex Systems. *Philos Trans R Soc Lond B Biol Sci* 1990; **327**:475–484
5. Business Continuity Institute: *Good Practice Guidelines 2010: A Management Guide to Implementing Global Good Practice in Business Continuity Management*. Caversham, Business Continuity Institute, 2010.
6. International Standards Organisation: *ISO 22301:2012 Societal security – Business continuity management systems – Requirements*. London, British Standards Institution, 2012
7. Botha J, Von Solms R: A cyclic approach to business continuity planning. *Information Management & Computer Security* 2004; **12**:328–337
8. Riley PW, Dalby DJ, Turner EA: Making acute hospital exercises more realistic without impacting on health care delivery. *Journal of Business Continuity & Emergency Planning* 2013; **6**:143–150
9. Rebmann Terri, Carrico Ruth, English JF: Lessons Public Health Professionals Learned From Past Disasters". *Public Health Nurs* 2008; **25**:344–352
10. Shaw GL, Harrald JR: Identification of the Core Competencies Required of Executive Level Business Crisis and Continuity Managers. *J Homel Secur Emerg Manage* 2003; **1**:1547–7355