# Lessons Learnt from a Prolonged Ventilation Failure in a Mycobacterial Reference Laboratory

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## INTRODUCTION

The National Mycobacterial Reference Service North & Central (NMRS-N&C), based in Birmingham Public Health Laboratory, contains two containment level 3 (CL3) laboratories to provide the following services to North & Central England:

1. **Primary processing** of samples for many hospitals within the West Midlands. Specimens will undergo acid fast bacili (AFB) staining, culture in liquid and solid media and positive cultures have a Ziehl Neelsen (ZN) stain. Specific specimens will also undergo PCR testing for rapid detection of *Mycobacterium tuberculosis (MTB)* and the presence of any mutations associated with Rifampicin resistance.

2. **Whole Genome Sequencing (WGS)** of positive mycobacterial cultures from primary isolates from laboratories across North & Central England. This identifies Mycobacterium and provides both susceptibility predictions and relatedness information for *MTB* isolates.

Laboratories with CL3 facilities to process Hazard Group 3 pathogens should have a documented risk assessment which includes a contingency plan in case of service interruption.

From June 2018, for a period of 6 weeks, NMRS-N&C had to implement its contingency plan because of a failure in the ventilation system. Consequently, both laboratories had no negative pressure leaving the staff unable to safely process any new primary or reference isolates.
The successful operation of the contingency plan, involving the use of supporting laboratories, allowed NMRS-N&C to continue to provide a primary processing and WGS service within its turnaround time of 7 working days.

We outline the methods used and lessons learnt from this laboratory outage.

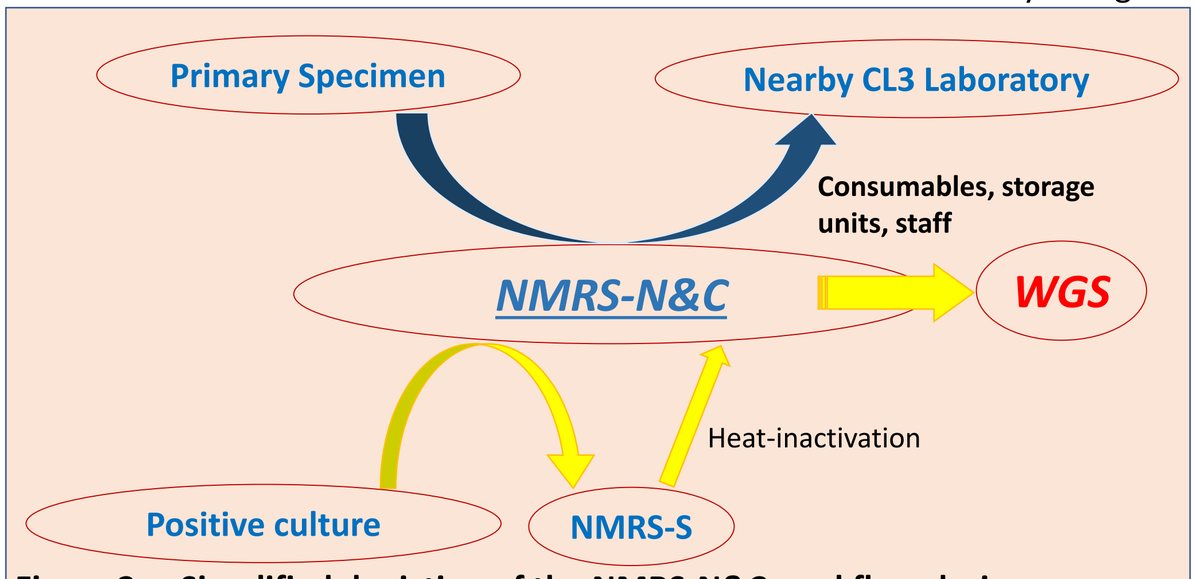


**Figure 2. Simplified depiction of the NMRS-N&C workflow during laboratory outage**

## LESSONS LEARNED

**There are over 20 lessons learnt from this outage.**
**The key lessons are:**

1. **Service contracts with the engineers of the smoke panel is essential to prevent delays in repairs**
2. **The importance of contingency arrangements for laboratory closure – from informal discussions, many do not have an agreed contingency plan**
3. **Visiting the contingency laboratory can identify problems early such as storage, consumables, difference in how culture bottles are processed**
4. **To consider installing an epi centre that allows staff to look at Mycobacteria cultures remotely from outside the CL3 facility**
5. **To always have a PCR machine outside the CL3 facility (performed on primary specimens and not positive cultures)**
6. **Set up a clear and secure communication stream between laboratories**
7. **Understanding the specimen reception process in contingency laboratory to recognise limitations and logistics regarding delivery and collection times**

## METHODS

The following key steps ensured NMRS-N&C remained functional during the laboratory outage and recovery period:

1. Creation of a dynamic project plan **(Figure1)**. This was reviewed weekly to oversee the management and timeline of the contingency plan during the laboratory outage and recovery period.

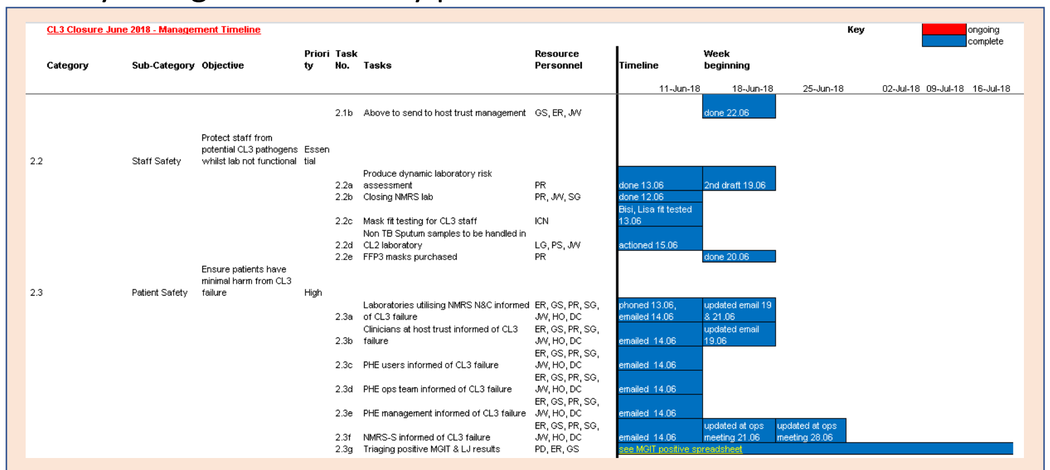


**Figure 1. A snapshot of the project schedule created. The full schedule had over 130 tasks**

2. Implementation of contingency plan **(Figure 2)**:
   a) Primary processing:
      I. All specimens were booked in at NMRS-N&C and transported to a nearby CL3 laboratory for primary processing and storage
      II. NMRS-N&C laboratory staff were deployed to this laboratory to process the referred primary work to minimise disruption to the supporting laboratories daily work
      III. Consumable and mycobacterial storage units were sent to the supporting laboratory as they did not have the capacity to store the extra workload
   b) WGS / Reference specimens:
      I. Specimens were booked in at NMRS-N&C and transported to NMRS-South (NMRS-S) in Colindale, London for heat-inactivation and storage. Heat-inactivation inactivates the Mycobacteria, making it safe to process outside of CL3 facilities.
      II. Heat-inactivated isolates were sent back to NMRS-N&C to have further WGS processing (DNA extraction, library preparation and sequencing). This minimised disruption at NMRS-S who were providing WGS service to South England.
   c) Cultures incubated and in-progress from before the laboratory outage:
      I. A risk assessment was completed allowing NMRS-N&C senior staff to enter the CL3 laboratories to read incubated cultures. This included updating the staff's FFP3 fit testing and PPE training
      II. All positive cultures were triaged by an NMRS-N&C clinician to decide whether the culture should be sent to NMRS-S for ZN & heat-inactivation. Specimens from patients with positive cultures within the preceding 2 months did not need to be sent to NMRS-S.
      III. PCR testing was performed if the NMRS-N&C clinician thought it would change patient management
   d) Return and storage of specimens once negative pressure restored.
      I. All samples leaving NMRS-N&C were placed on a tracker and this was used to retrieve samples stored at NMRS-S for archiving at NMRS-N&C.

## RESULTS

Overall, the contingency plan worked with thanks to the help and support of the contingency laboratories.
Without this assistance, there would have been significant delays in all Mycobacteria testing both within the West Midlands and probably in England as requests may have been diverted to NMRS-S which would have overwhelmed their service.

Within NMRS-N&C:
- AFB processing on primary specimens were delayed by 48 hours because of specimen transportation and processing at a contingency laboratory.

- WGS turnaround times were longer than normal but did not exceed the national target of 7 working days
- There were no rise in cross-contamination rates during the outage

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