TRAINING INTERVENTIONS FOLLOWING EXPOSURE INCIDENTS IN THE PUBLIC HEALTH LABORATORIES IN SOUTH AFRICA

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ABSTRACT

Introduction: Laboratory-acquired infections (LAI) are defined as all infections acquired through laboratories or laboratory-related activities, resulting from exposures to a wide variety of pathogens. Failure to anticipate presence of pathogenic organisms, complacency associated with long-term routine work and a lack of understanding of the biological risks are ever-present contributory factors. Reported *Brucella mellitensis* exposure incidents, highlighted the need for urgent and immediate intervention.

Methods: All reported incidents are investigated, and due to the severity of the implicated pathogen, urgent action was necessary. All reported incidents from 2016 – 2018 were also retrospectively analyzed. It was determined that training would need to be implemented to address system shortfalls. Policies and procedures are well described institutionally, but user adherence is lacking. Didactic and practical training was conducted. Training covered receiving office good laboratory practice (GLP), and national shipper training with a capacity building initiative aimed at developing trainers.

Results: Fifty-six receiving office staff and 36 laboratory staff (12 trainers) were trained from March to August 2018 in GLP and shipping, respectively. Metrics for success of these interventions are qualitative rather than quantifiable. Incidents will continue to be monitored and investigated.

Discussion: Effective incident reporting, in-depth investigation, incident response and immediate action are all vital in incident response. Organizations must ensure the provision of consistent training, as well as foster partnerships that allow for the transfer of knowledge relating to biosafety.

Conclusion: Course evaluations indicated that the courses were well received. The need for continual supervision, monitoring, immediate incident reporting and investigation of incidents remains a priority in the prevention of exposure incidents.

INTRODUCTION

Laboratory-acquired infections (LAI), defined as infections acquired through laboratory exposure to a wide variety of bacteria, viruses, fungi, and parasites (Wurtz et. al., 2016). *Brucella*, despite being a zoonotic disease, is considered a major cause of LAIs worldwide (Sophie et. al., 2004). Brucellae are Gram-negative facultative, intracellular coccobacilli, notorious for slow-growth - a contributory factor to their misidentification (Castrodale et. al., 2015). Clinical microbiology laboratories sporadically fail to anticipate or misidentify *Brucella* spp., resulting in increased risk of episodic exposure at both clinical and reference laboratories (Castrodale et. al., 2015). Brucellosis presents with a wide range of non-specific symptoms, and as a result brucellosis may not be immediately anticipated and diagnosed (Castrodale et. al., 2015). *Brucella* transmission occurs via inhalation of infected fluid aerosols, whereby the Brucellae gain entry through the respiratory mucosa (Castrodale et. al., 2015). For this reason, it is recommended that work with *Brucella* be carried out in a BSL3 laboratory (Fiori et. al.,2000). Approximately 2% of reported cases of human brucellosis, is attributed to LAIs with an attack rate in cases of accidental laboratory exposure, ranging from 30 to 100%, depending on the location of workers and the quantity of bacteria involved (Fiori et. al., 2000).

The importance of good laboratory practice (GLP), Biorisk Management (BRM) and an effective reporting and medical surveillance system is therefore highlighted and emphasized. It is further highlighted, that awareness should be created among laboratory staff regarding the risks of handling diagnostic specimens that could potentially be infected with high consequence pathogens on the benchtop without additional safety mitigation strategies.

Aim: To investigate the contributory factors leading to four separate *Brucella* exposure incidents, 2016 - 2018, involving 88 people from four(4) separate facilities in two South African provinces and to describe the immediate interventions taken to prevent the recurrence of such exposures.

MATERIALS AND METHODS

Data analysis

The National Health Laboratory Service (NHLS) has a robust electronic occupational health monitoring and reporting system in place, Occupational Health and Safety Information System (OHASIS) accessed by all NHLS staff for reporting all incidents, accidents, exposures and near-misses (hereafter collectively referred to as "incidents") . All OHASIS-reported incidents recorded between January 2016 and June 2018 were pulled from the database filtering by date, exported to excel and retrospectively analyzed using basic descriptive statistics. Four (4) major *Brucella* exposures were flagged by the system which led to urgent investigation and intervention .

Interventions

The NHLS has well described, institutionally implemented policies and procedures, but user adherence is variable, highlighted by the fact that the majority of *Brucella* exposures could have been avoided, had good laboratory practice (GLP) and basic BRM been followed as described in policy documents. Shortfalls urgently addressed through training—a series of didactic and practical training courses were conducted using a targeted approach.

There were 3 training courses given:

1. Basic BRM and GLP for receiving office personnel;
2. National shipper trainer development course to build national training capacity;
3. IATA shipper course to train laboratory personnel on the correct packaging and handling of all diagnostic clinical specimens.

Course 1: BRM and GLP for receiving office personnel

The course was developed to create awareness of BRM and improving GLP in receiving office personnel. In August 2018, 56 receiving office personnel from 11 NHLS laboratories in the most densely-populated province attended the BRM training held at the National Institute for Communicable Diseases (NICD), Johannesburg, South Africa. The training was conducted over three days; Day 1 – 17 people from 6 facilities, Day 2 – 19 from 6 facilities and Day 3 – 20 from 8 facilities). This training was the first of its kind in response to the Brucella exposure clusters reported between January 2016 and June 2018. **Aim**: to enhance sensitivity to GLP, BRM and handing specimens potentially containing high consequence pathogens.

Figure 1. Map of South Africa demonstrating the national footprint of NHLS laboratory branches

Courses 2 and 3: BRM/IATA shipper trainer development and IATA shipper training

These 2 courses were run in September 2018 and were supported by Sandia National Laboratories (SNL) and Defense Treat Reduction Agency (DTRA). **Aim**: To build national training capacity, by training 2 area managers per province who would then return to their regions and train employees on the correct packaging and shipping of clinical diagnostic specimens. Days 1—4 focused on trainer development of 12 trainers and on day 5, the new trainers developed their skills and built confidence by training an additional 24 NHLS employees from around South Africa.

RESULTS AND DISCUSSION

Data Analysis

A total of 1122 OHASIS entries were pulled from January 2016 to June 2018. A total of **7.8%** (88/1122) of incidents reported were for personnel with possible *Brucella* exposure, who required post-exposure prophylaxis and medical surveillance in the sampled period (2016 – n=67; 2017 – n=6; 2018 – n=15). There were 4 separate incident clusters reported with the highest number of exposures (i.e. 54/88) occurring in the second quarter of 2016 (cluster 1). Cluster 1 was reportedly traced through 4 different laboratories across 2 different South African Provinces. Figure 2 demonstrates the number of possible exposures reported between January 2016 and June 2018 that triggered the training intervention which ensued.

The majority (57%) of *all* 1122 incidents reported between January 2016 and June 2018 were attributed to workforce failures (Figures 3) due to lack of or inadequate training, adherence to policy or complacency.

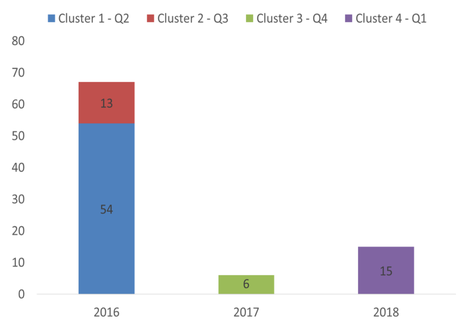

Figure 2. Number of possible Brucella exposures reported on OHASIS between January 2016 and June 2018 at NHLS laboratories throughout South Africa.

Contributory factors to *Brucella* incidents:

1. Lack of recognition of category A packaging
2. Poor understanding of the consequences of contact with highly pathogenic organisms
3. Poor laboratory practices
4. Culture of complacency
5. Poor or lack of appropriate mitigation strategies
6. Lack of attention to detail

Topics covered in the training included:

1. Use of the AMP (assessment, mitigation, performance) model for conducting risk assessments and implementation of mitigation strategies;
2. Hierarchy of controls for the effective mitigation of biological risks;
3. Working safely with unknown pathogens;
4. Identifying category A packaging;
5. Good laboratory practice;
6. Working safely in a class II biosafety cabinet.

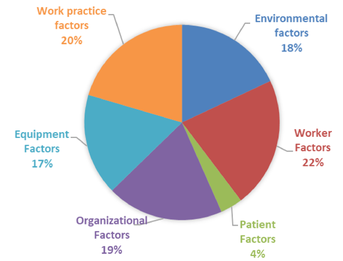

Figure 3. Contributory factors attributed to 1122 incidents reported on OHASIS, January 2016 - June 2018

Limitations identified

- Time constraints and staff accessibility: due to staff workloads, it was difficult to release staff for more than one day.
- Limited practical component for the training: proper handwashing and glove removal techniques, practical demonstration of safely working in a class II A2 biosafety cabinet.
- Limited baseline knowledge and/or understanding: current practices appear insufficient. Staff are aware of safety policies and practices; however there is a fundamental lack of understanding of "why" things are meant to be done in the described manner, leading to a culture of complacency and hidden behaviors. Staff were grateful for the training, as they genuinely did not realize the risks.
- Receiving offices do not have class II A2 biosafety cabinets: Receiving offices are responsible for receiving, registering and forwarding on a myriad of specimens, often times, these specimens are compromised (i.e. broken, leaking, misidentified) and thus pose significant risk to receiving office staff handling these samples on the bench.
- Specimens are sent incorrectly packaged: e.g. specimens arriving in syringes with needles still attached, biopsies and histology samples are sent in plastic packets (shopping bags), specimens leaking or broken, autopsy samples are sent in a manner that does not conserve the tissue integrity.
- Lack of reporting of possible exposures, incidents and near misses for lack of understanding of the severity of the possible risks or consequences, fear for condemnation, staff complacency, active discouragement for what is considered "over reporting".

CONCLUSION

Laboratory staff training and education is essential. Biological risk can be reduced and controlled by the correct application of internationally recognized procedures such as proper microbiological techniques, proper containment apparatus, adequate facilities, protective barriers, and special training and education of laboratory workers in standardized microbiological procedures and techniques and the use of containment devices, facilities, and protective barriers is necessary. Training and education about the epidemiology, pathogenicity, and biohazards of the microorganisms involved may prevent or decrease the risk. In this way, the scientific community may benefit from the lessons learned in the past to anticipate future problems (Coelho and García Díez, 2015).

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