Pertussis Testing: Pathogen and Laboratory Identification
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Introduction
Pertussis, also known as whooping cough, is an acute respiratory tract infection caused by Bordetella pertussis. Pertussis was first described in the 1500s. The term “pertussis” refers to a violent or intense cough, which was part of the early description of the illness.1,2

Epidemiology
The incidence of pertussis is highest in infants and children, and it declines substantially in individuals over the age of 14.3,4 Hospitalization and death are most common among infants, particularly those under 3 months of age. Vaccination has significantly decreased the incidence of pertussis in Canada, from an average of 156 cases per 100,000 population in the years preceding vaccine introduction (i.e., prior to 1943) to a low of 5 cases per 100,000 population between 2005 and 2011.5 In 2012, the national incidence spiked dramatically to 13.9 cases per 100,000 population, related to a number of localized outbreaks in multiple jurisdictions across the country. Several factors may have contributed to these sporadic outbreaks, including waning immunity among adolescents and adults, and low effectiveness of the combined diphtheria-tetanus-whole cell pertussis vaccine used in children between 1980 and 1997. Increased case detection may also be a consequence of improved diagnostic techniques and heightened physician awareness.4,5

Clinical Manifestation
The clinical presentation of pertussis is classically divided into 3 stages; the catarrhal stage, the paroxysmal stage, and the convalescent stage. The catarrhal stage develops insidiously after an incubation period of 7 to 10 days, and typically lasts for 1 to 2 weeks. Symptoms include nasal congestion, rhinorrhea, low-grade fever, sneezing, lacrimation, and conjunctival suffusion. These symptoms often mimic viral respiratory tract infections.1-4 As initial symptoms subside, a cough begins, marking the onset of the paroxysmal stage. This stage lasts approximately 2-6 weeks. The cough is described as a dry intermittent hack, and it evolves to paroxysms of cough followed by an inspiratory whoop.1-4 These paroxysms escalate over days to a week and plateau at a rate of 1 episode/hr.1-4 Post-tussive emesis and exhaustion are noted to be common. Interestingly, between fits of coughing, infants or young children often appear well. The final stage or convalescent stage lasts ≥2 weeks and during this period the number, severity, and duration of coughing episodes diminish.1-4

It is important to note that pertussis can occur in adolescents and adults. However, the symptoms do not exhibit the same distinct stages.1-4 Adults may complain of a sudden feeling of strangulation followed by uninterrupted coughs, the feeling of suffocation, a bursting headache, diminished awareness, and then a gasping breath, usually without a whoop.1-4

Microbiology
The genus Bordetella contains 10 species including the causative agent of pertussis, Bordetella pertussis.1,3 A closely related species Bordetella parapertussis also causes the clinical entity of pertussis. This species only accounts for approximately 5% of cases in North America.1-3 However, in Europe this organism contributes significantly to the overall number of reportable cases of pertussis.

Work Up in the Lab
Culture
B. pertussis is extremely sensitive to environmental conditions, especially desiccation. Specimens for culture must be collected and transported to the laboratory in special transport media or inoculated at the patient bedside to Regan-Lowe media for optimal sensitivity.1,4

Bacterial culture for B. pertussis identification is definitive and highly specific (100%), but sensitivity ranges from 12-60%.4,6 Furthermore, culture may take up to 7 to 12 days before colonies can be identified.4,6 Due to its low sensitivity, culture is no longer performed by DSM laboratories.

Nucleic Acid Amplification Tests
Nucleic acid amplification tests (NAAT) offer several advantages over culture for the detection of B. pertussis. These advantages included ease of specimen collection, improved test sensitivity (70-99%), and reduced turn-around-time for results. Further, prior antibiotic therapy has less of an impact on test performance.4,6,7

Although NAATs are highly sensitive, issues of specificity (ranging from 86-100% in the literature) are of concern. Amplification of target genes in closely related Bordetella species may potentially result in a false positive test.4,6,7 Thus, interpretation of results should be made in concert with symptoms and epidemiological information.4,6

The current diagnostic test performed by Diagnostic Services Manitoba is a NAAT that detects both B. pertussis and B. pertussis parapertussis. 

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. The lower limit of detection for this assay is 10 cfu/mL for *B. pertussis* and 100 cfu/mL for *B. parapertussis*. Specimens should be obtained by nasopharyngeal aspiration with saline (optimal) or swabbing the posterior nasopharynx. If a swab is selected, the swab must be Dacron, Rayon, or a flocked swab, as cotton and calcium alginate swabs contain inhibitors. Note that swabs of the anterior nasopharynx or throat are not acceptable as they harbor few of the cells in which *Bordetella* species replicate.

### Pertussis testing highlights:

**Who to test**
- Patients with signs and symptoms consistent with pertussis within the first 3 weeks of the characteristic cough.
- Do NOT test:
  - Asymptomatic individuals, contacts of a laboratory confirmed individual, or patients who have received 5 or more days of appropriate antibiotics.

**What to send**
- A nasopharyngeal aspirate (optimal) OR a swab of the posterior nasopharynx (see figure 1). Swabs MUST be either Dacron, Rayon, or flocked swabs.
- Do NOT send cotton swabs or calcium alginate swabs. These will not be accepted.
- Swabs of the anterior nasopharynx or throat are NOT acceptable.

**How to send a sample**
- Nasopharyngeal aspirates can be submitted in a sterile specimen container.
- Nasopharyngeal swabs are submitted in a sterile container (either cut or break off the swab in the container).
- Send all samples to the Health Sciences Centre Microbiology Laboratory.

**What results you can expect to receive**
- Results will indicate whether the patient sample is positive or negative for *B. pertussis* and *B. parapertussis*.

**Take home points:**
- Nucleic acid amplification testing is the preferred method of pertussis diagnosis and is available at DSM laboratories.
- A nasopharyngeal aspirate or nasopharyngeal swab should be submitted for a NAAT to the Health Sciences Microbiology Laboratory from any patient suspected of having pertussis.

### References