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Toxigenic *C. diphtheriae* in a donkey: Implications for zoonotic disease transmission and One Health Approach

Dr Chidubem Okechukwu, MBBS, MPH, CCFP

Dr Colin Lee, MD, MSc, CCFP(EM), FRCPC

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Land Acknowledgement

- We would like to acknowledge the traditional lands on which we are presenting today.
- Dr Okechukwu is in Sudbury and acknowledges the traditional territory of the Atikameksheng Anishnawbek and Wahnapitae First Nations, within the Robinson-Huron Treaty territory.
- Dr. Lee is in Toronto and acknowledges that he is on the traditional territory of many nations, including the Mississaugas of the Credit, the Anishnabeg, the Chippewa, the Haudenosaunee, and the Wendat peoples, and now home to many diverse First Nations, Inuit, and Métis peoples.
- We are grateful to live, learn, and work on these lands and to honour the Indigenous peoples who have cared for them since time immemorial.

Disclosure

- Dr Chidubem Okechukwu does not have any conflict of interest to disclose.
- Dr Colin Lee received an honorarium from Hologic for participation in an Advisory Board meeting on Bacterial Vaginosis held in August 2025. No other conflicts of interest are declared.

Learning Objectives

At the end of the webinar, attendees will be able to

- Describe features and epidemiology of human diphtheria illness and the importance of immunization
- Describe from a One Health perspective the potential transmission of zoonotic diphtheria toxin-causing infections
- Describe the challenges in human contact management and interagency response for zoonotic infections that are not notifiable in animals.

Outline

- Human diphtheria
- Background & One Health relevance
- Case presentation & laboratory findings
- Public health response & challenges
- Lessons & recommendations

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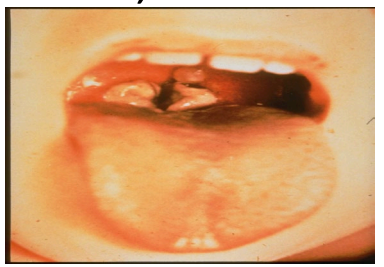
What Causes Human Diphtheria?

- Caused primarily by toxin-producing strains of *Corynebacterium diphtheriae* where humans are the main reservoir
- Other causative species include toxigenic strains of *Corynebacterium ulcerans* and *Corynebacterium pseudotuberculosis* which can be found in the environment and animals, including domestic animals such as cats, dogs, and horses

Clinical Features of Diphtheria

- Respiratory Diphtheria
  - membranous pharyngitis with fever, enlarged anterior cervical lymph nodes, and oedema of the surrounding soft tissue



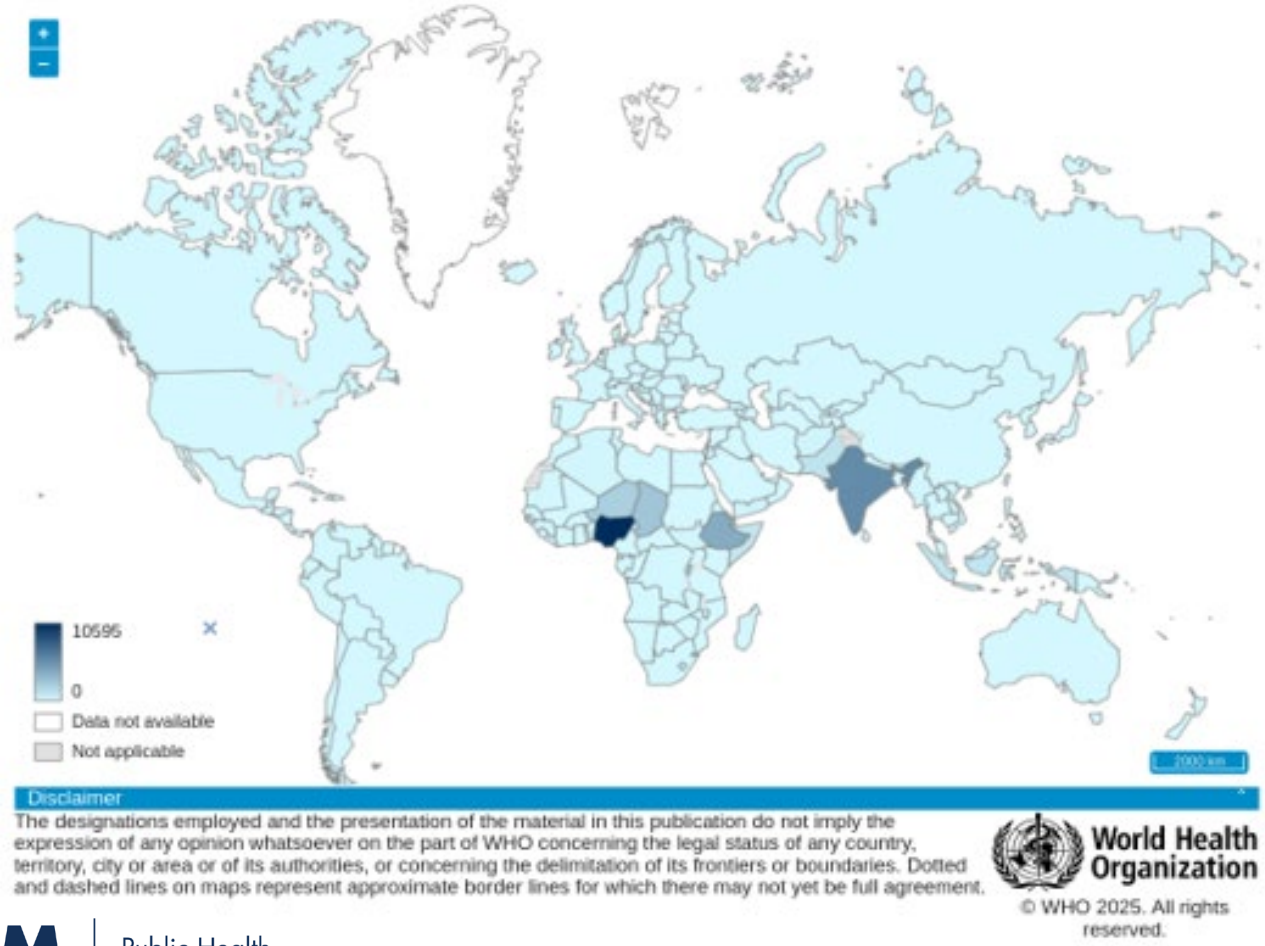
- Cutaneous Diphtheria
  - usually appears on exposed limbs, particularly the legs.
  - lesions start as vesicles and quickly form small, clearly demarcated, and sometimes
  - multiple ulcers that may be difficult to distinguish from impetigo
- Complications can include myocarditis, renal failure, and death
- Rare in high-income countries

Images courtesy of Centers for Disease Control and Prevention

Clinical Features of Diphtheria (2)

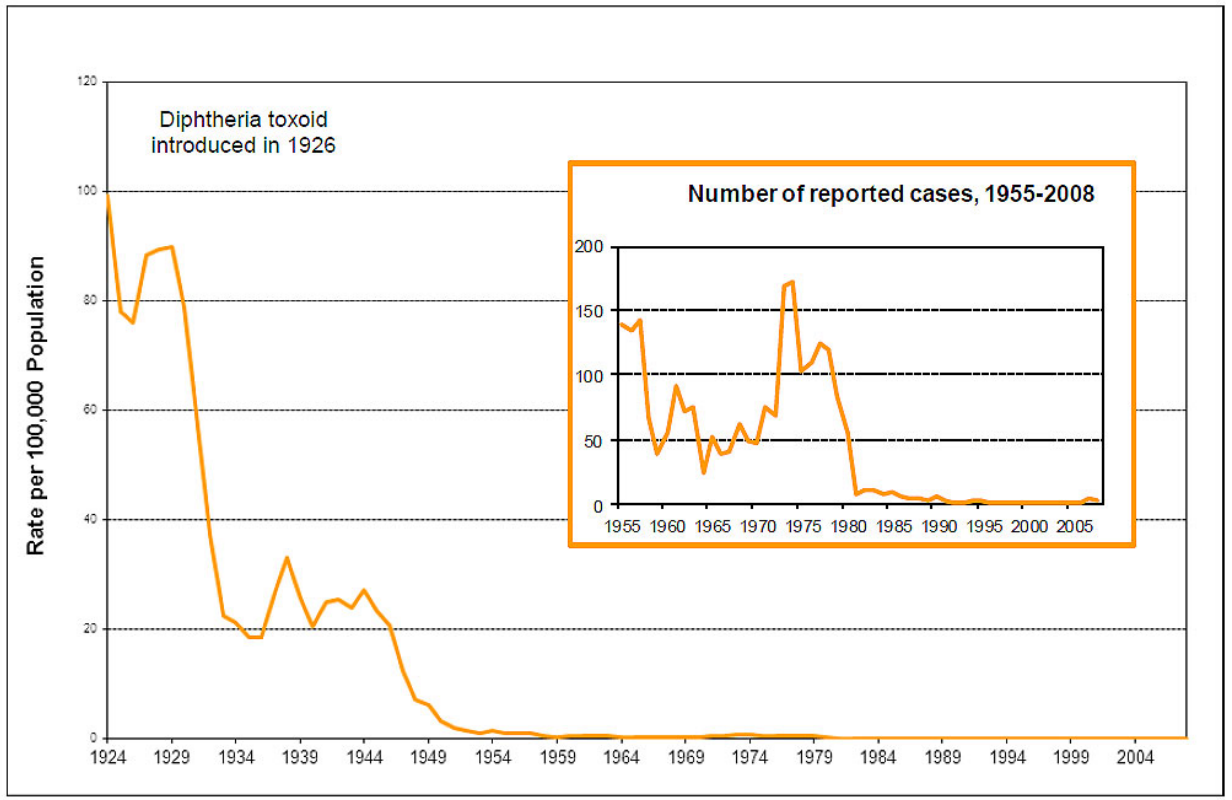
- Incubation period ranges from 2–10 days.
- The mode of transmission is direct contact for cutaneous lesions and via droplet for respiratory diphtheria.
- Severe diphtheria illness is caused by the toxin.
- Diphtheria toxoid vaccine induces production of anti-toxin antibodies to prevent severe illness and is given in combination with tetanus vaccine.
- Diphtheria vaccine does not prevent colonization, though it is highly effective at preventing disease and reducing the spread of infection

Yearly Reported Cases of Diphtheria



WHO: The Global Health Observatory

Diphtheria - reported cases and incidence, Canada, 1924-2008



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From Canadian Immunization Guide

Diphtheria in Canada

- 19 cases were reported between 1993 and 2012 in Canada
- The most recent fatality in Canada was in 2018.
- Serosurvey of young healthy adult Canadians revealed that approximately 20% of individuals do not have adequate levels of antibodies for diphtheria.

One Health & Zoonotic Risk

- Shared environment: humans, animals, soil
- Animals can carry toxigenic and non-toxigenic strains
- No confirmed zoonotic transmission yet of toxigenic *C. diphtheriae*

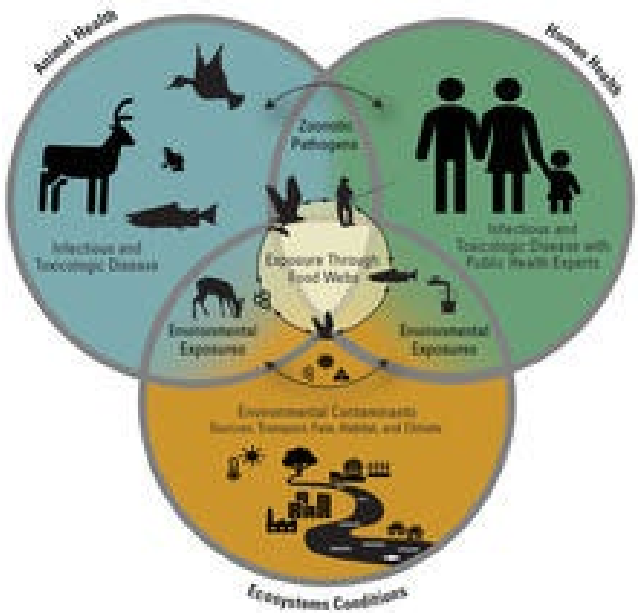
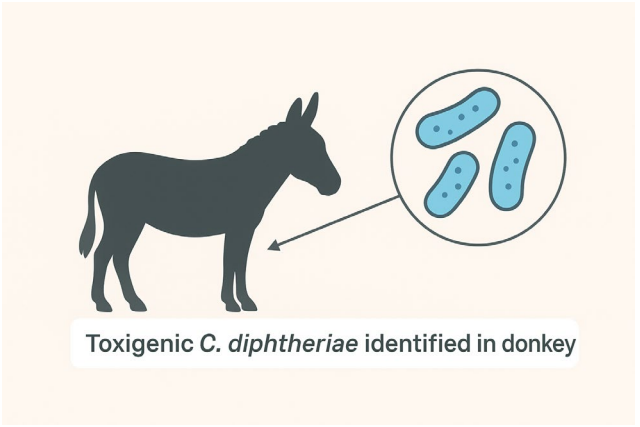


Image courtesy of USGS

Case Overview

- Ontario, Canada – Sept 2024
- Donkey with chronic leg wounds
- First time isolation of toxigenic *C. diphtheriae* animal case in Ontario
- First documented donkey case in the world



Toxigenic *C. diphtheriae* identified in donkey

Laboratory Findings

- Mixed culture: *C. diphtheriae, P. aeruginosa, Streptococcus*
- PCR positive for toxin gene at Animal Health Lab using a research-use-only PCR assay.
- Lab confirmation at National Microbiology Lab by PCR for toxin gene and the modified Elek test for the phenotypic detection of the expressed diphtheria toxin.

Public Health Human Contact Management

- Necessary only for toxigenic cases
- Investigation and monitoring of close contacts initiated before NML confirmation given the high specificity of the Animal Health Lab test.
- Swabbing: include a nose and a throat swab and swabs of any skin lesions
- Chemoprophylaxis of close contacts while awaiting results
  - treat incubating disease in recently exposed contacts
  - eliminate carriage and thereby reduce the risk of exposure to other susceptible contacts
- Immunization of close contacts if last diphtheria dose was more than 5 years ago (Ontario Infectious Disease Protocol and US guidelines) or more than 1 year ago (UK and Australia guidelines)

Contact Management of the Donkey

- 7 human close contacts
- Risk assessment
- PEP offered : antibiotics (Azithromycin + vaccine)

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Table of Human Close Contacts

Human Contacts	Year received last dose of diphtheria-containing vaccine	Interventions
1	2019	Tdap Provided; Took Antibiotic PEP 5/7 days
2	2022	Tdap Provided; Took Antibiotic PEP 5/7 days
3	2022	Declined Tdap; Did not take Antibiotic PEP
4	2018	Tdap Provided; Took Antibiotic PEP 5/7 days
5	Unsure	Tdap Provided; Did not take Antibiotic PEP
6	2021	Tdap Provided; Did not take Antibiotic PEP
7	2019	Declined Tdap; Did not take Antibiotic PEP

Outcomes

- All cultures were negative
- PEP provided in some cases
- Health education provided
- Follow up

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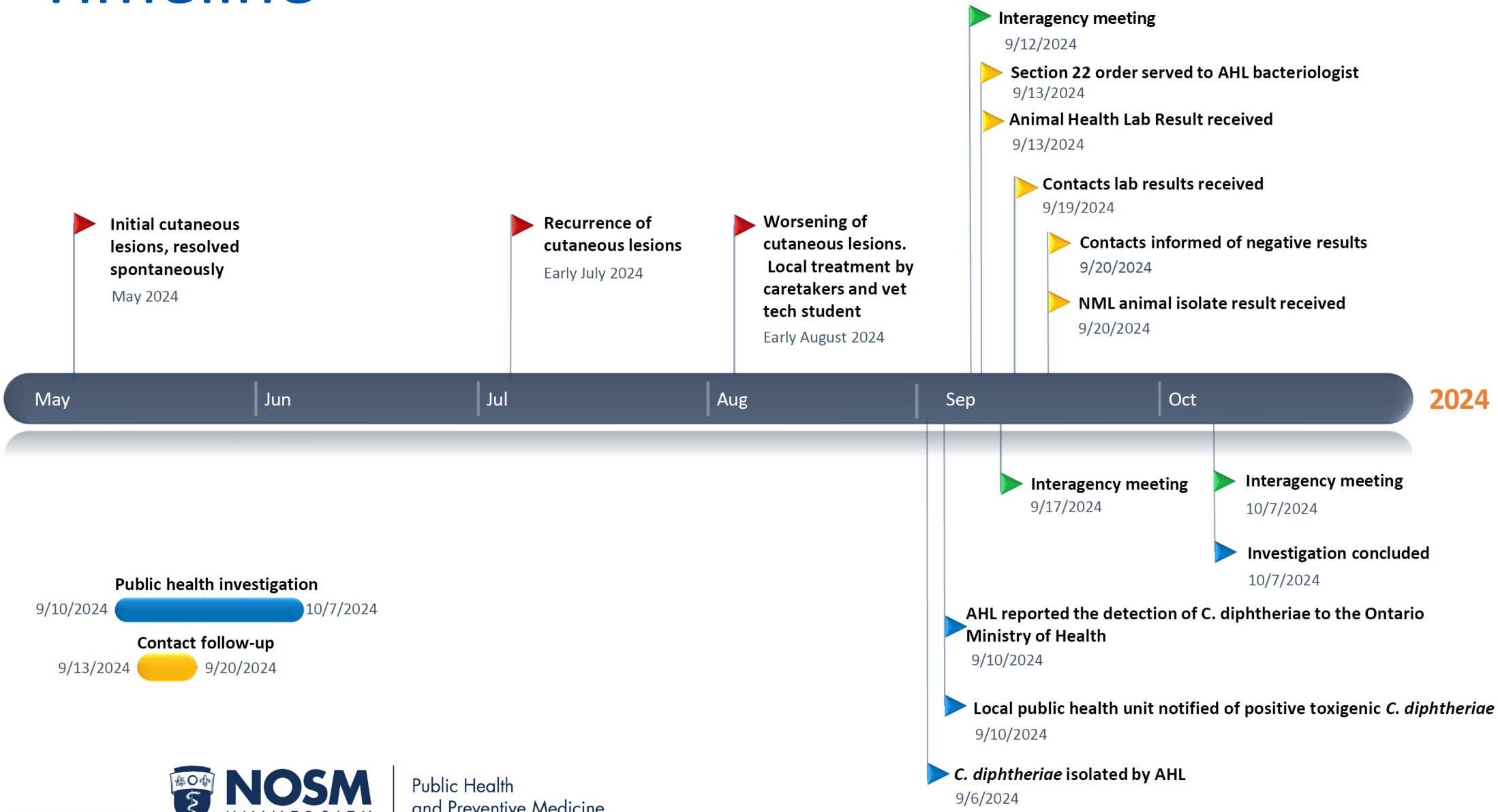
Timeline



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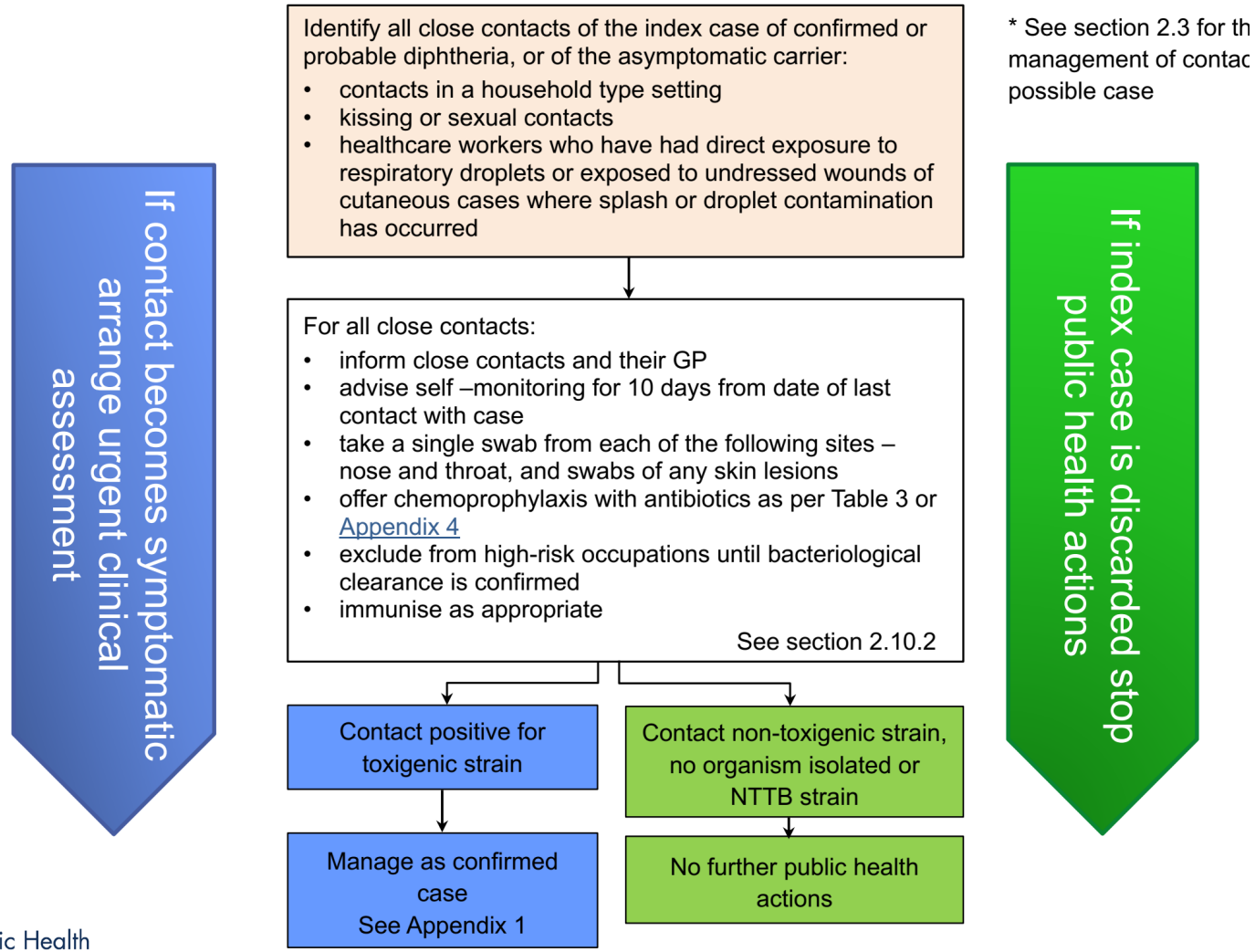
UK Algorithm for Close Contact Management of a Toxigenic Case

Public health control and management of diphtheria in England: 2025 guidelines



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Public Health Challenges

- Absence of standardized surveillance and mandatory reporting for animal cases for potentially toxigenic *Corynebacterium diphtheriae* and potentially other zoonotic diseases of importance to human health
- Gaps delayed timely public health response
- Delay in confirmation of *C. diphtheriae* result
- Stigma of public health involvement in animal infections

Interagency Response

- Collaboration:
  - Animal Health Laboratory (AHL), Public Health Ontario (PHO), local Public Health unit, Office of the CMOH, Ontario Ministry of Agriculture, Food and Agribusiness (OMAFA) and the National Microbiology Lab (NML)
- Critical lab result communication
- Contact management
- First-time case complexity

Examples of lab reports of *C. diphtheriae* in humans

Case 1

- 40 year old presenting to the ER with out of hospital cardiac arrest. Case is of no fixed address. Intubated and in ICU. Patient had a similar episode a few months ago and was believed to be due to a drug-related sympathomimetic toxidrome. Sputum culture positive for *C. diphtheriae*

Case 2

- 35 year old presenting to the ER "with gradual worsening redness and lesions of both lower legs. He states he does do cocaine and weed sometimes, denies crystal meth or intravenous drugs. He is on ODSP. He states he is not homeless but is with the homeless population a fair bit". Wound culture positive for MRSA, GAS, and *C. diphtheriae*

Steps taken for lab reports of *C. diphtheriae* in humans

- Samples sent from hospital lab to PHO lab for confirmation and further testing
- Diphtheria – Culture, Reference Isolates Identification Confirmation & Toxin Production Confirmation | Public Health Ontario
- No public health actions taken immediately given that clinical presentations do not suggest toxigenic diphtheria infections and the vast majority of non-travel related cases are not toxigenic.
- Reassured hospital that staff exclusion, testing, PEP or immunization are not required unless toxin results are positive. Droplet and contact precautions.
- Both cases ended up being classified as non-toxigenic

Lessons Learned

- Animal reservoirs possible
- Rapid interagency coordination vital
- Legislative gaps remain

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Conclusions

- The isolation of toxigenic *Corynebacterium diphtheriae* from a donkey in Ontario shows that animal cases, though rare, can pose a zoonotic risk through direct contact with lesions.
- Vigilant health measures, including close contact management and post-exposure prophylaxis, are necessary to protect exposed individuals.
- Maintaining up-to-date diphtheria booster vaccinations across the population remains an essential component of prevention.
- Strengthening surveillance, improving reporting requirements, and enhancing communication between veterinary and public health laboratories are critical for a timely response.
- A coordinated One Health approach is vital to address knowledge gaps and ensure preparedness for re-emerging zoonotic diseases.

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Thank you for attending our presentation

Dr Chidubem Okechukwu cokechukwu@nosm.ca

Dr Colin Lee colin.lee@smdhu.org

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