

Lessons from campus outbreak management using test, trace, and isolate efforts

Nita Bharti^{1*}, Cara Exten², Valerie Fulton³, Robin Oliver-Veronesi³

¹ Biology Department, Center for Infectious Disease Dynamics, Penn State University, University Park

² College of Nursing, Penn State University, University Park

³ University Health Services, Penn State University, University Park

* corresponding author: nxb909@psu.edu, 814-863-9545, W-253 Millennium Science Complex, University Park, 16802

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Summary

In 2017, Penn State University's campus experienced a mumps outbreak coincided with unrelated restrictions on social gatherings. University Health Services implemented testing, contact tracing, and quarantine protocols. Approximately half of the supplied contact tracing information was usable, ~70% of identified contacts were reached, and <50% of those contacted complied with quarantine protocol. Students reported 5-10 contacts on average. Findings from this outbreak can inform future outbreak management on college campuses, including COVID-19.

Introduction/Mumps Background

Mumps is a transmissible disease caused by a paramyxovirus. In adults, clinical cases present as mild disease with headache, fever, and swelling in the salivary glands. Untreated cases may progress to complications such as encephalitis or meningitis. The case fatality rate due to complications is 1/10,000¹.

Mumps is transmitted from an infected to a susceptible individual through saliva or respiratory droplets. The (pre-vaccination) basic reproduction number for mumps is estimated around 10-12. Mumps has an average incubation period of 16-18 days².

An estimated 91.5% of children in the US receive measles-mumps-rubella (MMR) immunizations before they are 35 months old³. Since August 2016, new students and all students living in university housing must provide proof of MMR immunization to Penn State University (PSU).

Outbreak Summary

In 2017, PSU's University Park campus of ~38,000 students experienced a mumps outbreak. Eighty-five student cases of mumps were diagnosed through University Health Services (UHS) in 2017, with an additional 30+ cases in 2018. PSU's UHS implemented contact tracing, testing, quarantine, and isolation to interrupt transmission. Positive test results triggered contact tracing. Using CDC guidelines for mumps, a contact was defined as any individual who was within 3 feet of the case for a prolonged period, or had direct exposure to a case's respiratory secretions via droplets or objects during their infectious period (2 days before or 5 days after symptom onset)⁴. Students were not consistently cooperative with contact tracing efforts; 81 of 85 cases provided

information for contact tracing, and an estimated 50% of contact information was usable. Students who completed contact tracing reported an average of 5-10 contacts (range 0-34+). Reporting 0 or 1 contacts indicated non-compliance.

Close contacts were predominantly reported outside of classrooms. No secondary cases were linked to a primary case solely through classroom exposure. The self-reported social behaviors that most often led to exposure and transmission were co-attendance at social gatherings and sharing drinks. Contact tracing is a valuable tool for identifying social interactions ⁵. Likely reasons for low student compliance in contact tracing during the mumps outbreaks are described below.

1. The mumps outbreak coincided with disciplinary actions that prohibited parties at fraternities. Compliance declined when social interactions occurred at prohibited events. Contact tracing in these scenarios was unsuccessful on two levels.
 - a. Students did not want to admit they attended a prohibited event, though underage drinking did not deter compliance.
 - b. Students did not want to place their contacts at prohibited events.
2. When contact tracing was successful in identifying exposed contacts, those individuals were difficult to reach. Due to deliberate avoidance of phone calls and emails, exposed contacts did not receive information regarding proper quarantine procedures or medical advice. Following first attempt phone calls, approximately 33% of calls were returned. After multiple efforts, approximately 70% of contacts were reached. The average number of days to reach a contact was not documented, but will be in the future.
3. When contacts were successfully reached, many did not comply with quarantine measures. ~50% of the secondary contacts who could be reached did not respond to quarantine guidelines, which UHS could not enforce.
4. Overall, students did not consider the threat of mumps infection to be significantly detrimental to their health. This attitude may have reduced compliance with preventative guidance. Different pathogens may yield different responses.

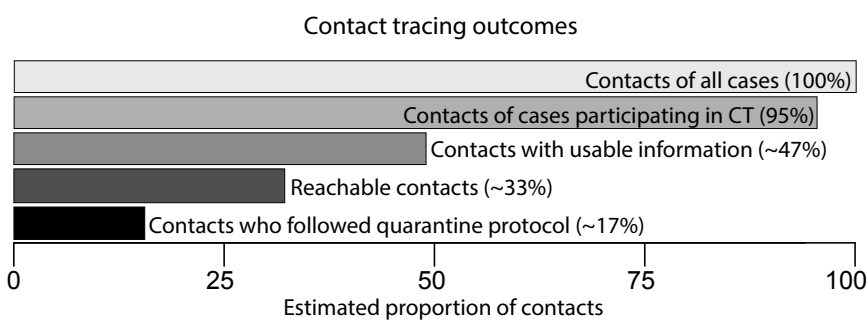


Figure 1: Out of 85 cases, 81 participated in contact tracing (CT), half of the information supplied was usable, 70% of those contacts were reached, and half of those agreed to comply with quarantine guidelines.

Future Outbreak Management

This mumps outbreak provides valuable information that can inform aspects of university responses to improve compliance for future contact tracing efforts on campus, particularly in response to SARS-CoV-2 circulation. To encourage students to provide prompt and honest contact information and comply with health guidelines ⁶, the following efforts should be considered:

1. Incentivize students to honestly report all recalled contacts.

2. Incentivize students who are identified as secondary contacts to respond to contact tracers when attempts are made to reach them and to follow quarantine guidelines (consider common referral strategy: reward both case and contact when contact is confirmed).
3. Clearly explain the privacy policy that the primary case's identity is not revealed to secondary contacts when they are contacted regarding potential exposure (though students in tight social groups may deduce who identified whom).
4. Remove all possible punishment for reporting contacts incurred during prohibited activities, particularly as social distancing is enforced and gatherings are banned.
5. Provide clear and honest messaging regarding the seriousness and severity of SARS-CoV-2 (consider partnering with campus-wide philanthropic missions for messaging and student-led outreach).
6. Make isolation and quarantine procedures appealing, including quality meal provisions and comfortable quarters, and minimize the impact on students (no additional financial burden, minimize effort for students and instructors to continue instruction, etc.).

For COVID-19, universities may plan for most students to identify 5-10 close contacts and employ appropriately sized contact tracing teams ⁷. These numbers can also help guide estimates for testing, growth rate of demand for quarantine quarters, and associated costs.

Class schedules can identify classroom contacts, but mumps transmission occurred in social settings. Minimizing testing delays and identifying social contacts will significantly reduce pathogen transmission.

Students in quarantine and isolation need daily checks and substantial support. They require monitoring for symptom development, improvement, and decline, with access to medical care as necessary. Outbreak mitigation is strongly dependent on student compliance with isolation and quarantine guidelines locally. Students should not travel to their parents' homes, where they may put other individuals and communities at risk.

Parents may strongly influence students' health decisions. University communications should include families. This information should emphasize 1) the importance of prompt contact tracing compliance, 2) that contact tracing programs and university disciplinary bodies are unlinked, and 3) the importance of completing quarantine and isolation periods at the university to avoid inter-community spread.

Conclusion

To effectively manage transmissible pathogens, students must cooperate with university outbreak management efforts and comply with behavioral interventions. Universities must provide timely, transparent outbreak updates, develop clear guidelines for action, and reward compliance in contact tracing, quarantine, and isolation protocols. Student compliance with behavioral interventions and contact tracing can save lives. Universities must emphasize the health benefits to individual students and the community.

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References

1. Centers for Disease Control and Prevention. Mumps for Healthcare Providers. *CDC Mumps* <https://www.cdc.gov/mumps/hcp.html> (2019).
2. Centers for Disease Control and Prevention. Manual for the Surveillance of Vaccine-Preventable Diseases. *Chapter 9: Mumps* <https://www.cdc.gov/vaccines/pubs/surv-manual/chpt09-mumps.html> (2018).
3. Centers for Disease Control and Prevention. *National Center for Health Statistics: Immunization*. <https://www.cdc.gov/nchs/fastats/immunize.htm> (2017).
4. Centers for Disease Control and Prevention. CDC guidance for public health authorities on use of a 3rd dose of MMR vaccine during mumps outbreaks. *CDC Mumps Home For Health Departments* <https://www.cdc.gov/mumps/health-departments/MMR3.html> (2019).
5. Keeling, M. J., Hollingsworth, T. D. & Read, J. M. Efficacy of contact tracing for the containment of the 2019 novel coronavirus (COVID-19). *J Epidemiol Community Health* jech-2020-214051 (2020) doi:10.1136/jech-2020-214051.
6. Kretzschmar, M. E. *et al.* Impact of delays on effectiveness of contact tracing strategies for COVID-19: a modelling study. *The Lancet Public Health* doi:10.1016/S2468-2667(20)30157-2.
7. Watson, C., Cicero, A., Blumenstock, J. & Fraser, M. *A National Plan to Enable Comprehensive COVID-19 Case Finding and Contact Tracing in the US*. https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2020/200410-national-plan-to-contact-tracing.pdf (2020).