



Cost of responding to the 2017 University of Washington Mumps Outbreak: A Prospective Analysis

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Abstract

Objectives: To estimate costs of labor and materials by the University of Washington (UW) and state and local public health departments (PHD) to respond to the February–June 2017 UW mumps outbreak, where 42 cases were identified among students (primarily sorority and fraternity members), staff, and associated community members

Design: We applied standard cost analysis methodology using a combined public health and university perspective to examine the cost of responding to the outbreak.

Setting: UW's Seattle campus encompasses 703 acres with ≈32,000 undergraduate students. Nearly 15% of the undergraduate population are members of fraternities or sororities. Housing for the fraternities and sororities is adjacent to the UW campus and consists of 50 houses.

Participants: During the outbreak, customized costing tools based on relevant staff or faculty positions and activities were provided to UW and Public Health—Seattle & King County, populated by each person participating in the outbreak response, then collected and analyzed. Laboratory hours and material costs were collected from Washington Department of Health and Minnesota Department of Health.

Main Outcome Measure: Labor and material costs provided by UW and PHD during the outbreak were collected and categorized by payer and activity.

Results: Total costs to UW and PHD in responding to the outbreak were \$282,762 (\$6,692 per case). Of these, UW spent \$160,064, while PHD spent \$122,098. Labor accounted for 77% of total outbreak costs and UW response planning and coordination accounted for the largest amount of labor costs (\$75,493) overall.

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Conclusions: Given the current university and public health department budget constraints, the response to the outbreak amounted to a significant use of resources. Labor was the largest driver of costs for the outbreak response; UW labor costs--related to campus response planning and coordination--dominated the total economic burden from public health and university perspectives.

1. Introduction

Mumps is an acute viral illness that usually presents with swelling of the parotid or other salivary gland(s); up to one-third of infections can be asymptomatic in an unvaccinated population. (1, 2). Mumps is vaccine preventable. In 1977, the United States (U.S.) Advisory Committee on Immunization Practices (ACIP) recommended one dose of mumps vaccine for all children at any age after 12 months (1). In 1989, children began receiving two doses of mumps vaccine after implementation of the two-dose measles ACIP vaccination policy using the combined measles, mumps, and rubella (MMR) vaccine (1, 3). After the vaccine recommendations were enacted, reported mumps cases fell more than 99% in the U.S. accompanied by substantial savings in healthcare costs (4, 5). The mumps component of the MMR vaccine is 78% effective after one dose (range: 49%–92%) and 88% effective (range: 31%–95%) after two doses (1, 6).

Since 2012, an increase in mumps cases and outbreaks has been reported to the Centers for Disease Control and Prevention (CDC), primarily associated with college settings (7, 8). These outbreaks ranged in size from three to several hundred cases, mostly affecting young adults, and are likely the result of a combination of factors, including <90% vaccine effectiveness and waning of vaccine-induced immunity over time, lack of exposure to wild-type virus, and close contact that leads to increased risk for exposure coupled with behaviors that increase the risk for transmission (9). There is insufficient publicly available documentation of the cost of these outbreaks and only one recently published study on the cost of a mumps outbreak in a college setting (10).

On February 8, 2017, a suspected case of mumps in a member of a sorority at the University of Washington's (UW) Seattle campus was reported to Public Health—Seattle & King County (PHSKC). By June 6, 2017, 42 mumps cases were identified among UW students (primarily sorority and fraternity members), staff, and associated community members (11); no hospitalizations or deaths occurred. In a university-wide effort, UW collaborated with PHSKC and Washington State Department of Health (WADOH) to rapidly respond to and contain the outbreak. The UW outbreak occurred amid Washington State's largest mumps outbreak in 40 years, although the two outbreaks were unrelated (different virus lineages in specimens tested) (11–14). This study reports the economic impact of the 2017 UW mumps outbreak on UW and the state and local health departments.

2. Methods

Setting

UW's Seattle campus encompasses 703 acres with approximately 51,000 students, of which about 32,000 are undergraduates (15). Nearly 15% of the undergraduate population are members of fraternities or sororities. Housing for the fraternities and sororities is the largest

single consolidated area of fraternity and sorority housing in the nation; it is adjacent to the UW campus and consists of 50 houses. Approximately 3,900 members reside in fraternity and sorority housing, and approximately 700 additional members live in other accommodations (16). Members not living in fraternity and sorority housing may still participate in daily meals and events sponsored by the fraternities and sororities. The fraternities and sororities intermingle socially and academically. UW reported >99% coverage with 2-doses of MMR vaccine among all students (11).

Outbreak and Public Health Response

To contain the outbreak, UW worked with PHSKC to investigate suspected cases and identify contacts. All clinical specimens (buccal swab and urine) were sent to WADOH for laboratory testing (n=65) and a subset (n=17) were also sent to the Minnesota Department of Health (MNDOH), which is the regional Vaccine Preventable Diseases (VPD) reference center (17).^{*} After the first reported case on February 8, 2017, investigators identified 41 more cases, with onset dates from February 6 – June 6, 2017 (Figure 1). Of the 42 total cases, 32 were among UW fraternity and sorority members, 4 were among other students residing in UW dormitories or off-campus housing, 5 were socially linked to UW, and the remaining case was in a UW faculty member. Cases were reported in 20 of 50 fraternity and sorority houses, comprising 2259 (49%) of approximately 4600 total fraternity and sorority members on UW campus.

Alongside numerous response labor activities, including providing clinical services and dedicated food and housing services to patients in isolation, UW implemented an outreach and education campaign. The campaign included campus-wide emails to faculty, staff and students to inform of the initial mumps case, meeting with fraternity and sorority presidents, providing blog posts announcing the mumps outbreak at UW, responding to media inquiries, distributing communication materials, and running focus group testing of mumps messaging[†]. By March 6th, the attack rate of 6/1,000 in a close contact setting--the fraternities and sororities --supported the consideration for use of an additional dose of MMR vaccine for outbreak control according to CDC guidance at that time (presented in the *2012 Manual for the Surveillance of Vaccine-Preventable Diseases*).[‡]

UW checked registrar's records for students in sororities and fraternities and found all students were up to date on MMR vaccine with two doses on record. PHSKC evaluated 2-dose MMR coverage in the UW student population and noted that coverage in their general student population was high (>99%). Two MMR doses are required to attend UW. Given the situation of a defined target population with intense close contact known to be high risk for transmission based on previously reported outbreaks, high 2-dose coverage, and evidence of continued transmission despite implementation of standard control measures, PHSKC, in

^{*}Specimens sent to MNDOH: (1) Specimens that could not be tested at WADOH because of the surge during the larger state outbreak. (2) Urine specimens and specimens needing genotyping, which are routinely sent because MNDOH is equipped to process these specimens.

^{††}Although UW does have an emergency outreach system, the system was not utilized because the university did not consider it was necessary to use given the massive outreach and education campaign.

[‡]This publication has been archived and is no longer available online. Readers may contact ncirddvdmrhp@cdc.gov for more information.

collaboration with UW, decided to offer a third dose of MMR to students in sororities and fraternities. A total of seven MMR vaccination clinics were offered during the outbreak; four coordinated by PHSKC from March 6–9, 2017 and three by UW on March 27 and 30, 2017 (Figure 1). All seven clinics were located at sorority and fraternity houses. The Office of Sorority and Fraternity Life promoted all of the clinics as free and voluntary for the fraternity and sorority houses where cases were identified, although the vaccine was free and available to any student holding a UW identification card. PHSKC provided the first 406 doses of MMR vaccine purchased at CDC contract prices. After those doses were administered, UW provided 538 doses privately purchased. Of the three clinics coordinated by UW, both the university health staff and a contracting agency hired by UW administered vaccines. During March 29 – May 16, 2017, 43 more privately purchased doses of MMR vaccine were provided by UW at the student health center when requested by students. To avoid barriers to vaccination, neither UW nor PHSKC sought insurance reimbursement.

To coordinate the outbreak response, starting March 13, UW staff met daily for the first month, mostly via conference call, then two to three times per week the following month, and then weekly for the remaining month of the outbreak. UW staff held separate meetings/calls to plan clinics to administer additional doses of MMR vaccine. Planning for the vaccination clinics was complicated and time consuming because of the off-label use of an additional MMR vaccine dose (standard labeling for MMR vaccine indicates administration of two doses). Substantial time was spent planning the finances and logistics of additional MMR clinics that ultimately were not held because the outbreak ended.

Data collection

We defined the study period as February 8, 2017, when the first suspected UW case of mumps was reported to PHSKC, through June 23, 2017, when UW initiated their after-action plan, nearly three weeks after the last reported case. This analysis uses traditional cost analysis methods from a public health and university perspective (18). Labor and material costs (such as the cost of vaccines, syringes, laboratory tests, and the cost of the vaccination contractors) were mainly collected prospectively and categorized by payer and activity. Wages for each respondent, which included fringe benefits and department overhead[§], were collected from UW, PHSKC, WADOH, and MNDOH. For ease of tracking hours by activity, customized costing tools were created for UW and PHSKC during the outbreak. A list of basic response activities, positions, and departments was sent to both UW and PHSKC. We worked with representatives from each institution to tailor the lists to their specific daily activities. For example, ‘Provide specialized housing or food services for students with mumps’ was an activity listed on the UW costing tool, but not the PHSKC tool. Once the lists were finalized, drop down menus were created for simplicity of daily data entry of hours by activities. The costing tools were distributed to UW and PHSKC, populated by each person participating in the outbreak response, then collected and analyzed by CDC. Response activities were categorized as containment or vaccination-related. Containment

[§]PHSKC reported total costs per day per respondent inclusive of fringe benefits and overhead. UW, WADOH, MNDOH reported overhead and fringe benefits separately so CDC calculated total per day costs inclusive of fringe benefits and overhead. Both fringe benefits and overhead varied widely across UW, PHSKC, WADOH, and MNDOH. Further, overhead was only charged for one department from UW, but all of PH departments. Lastly, some positions at UW are not paid fringe benefits.

activity subcategories included communication, case and contact investigation, response planning and coordination, preparing reports, and laboratory testing. Vaccination activity subcategories included vaccination clinic planning and vaccination clinic operations. Laboratory hours and material costs were collected from WADOH and MNDOH. Vaccine and vaccine supply costs were collected from UW and PHSKC. Public health (PH) data includes labor and material costs from PHSKC**, WADOH, and MNDOH combined. All expenses are in 2017 U.S. dollars.

3. Results

Total costs incurred responding to the 2017 UW Mumps Outbreak were \$282,762 (or \$6,732 per case), including material costs and 2,692 hours of labor accrued. UW spent \$160,664 (\$3,825 per case), including material costs and 1,495 logged hours and overall PH costs were \$122,098 (\$2,907 per case), including material costs and 1,197 logged hours (Table 1). The number of contacts was not available to compute cost per contact. However, if sorority and fraternity population were to be used as a proxy, the total cost per contact would be \$61/contact.

Comparing outbreak containment versus vaccination-related activities, containment-related hours and labor costs were three-fold higher than vaccination-related activities (Table 2). PH spent \$75,295 (957 hours of labor) on containment-related costs and \$23,472 (240 hours of labor) on vaccination-related costs. UW spent \$91,507 (1096 hours of labor) on containment-related costs and \$26,483 (400 hours of labor) on vaccination-related costs. Adding material costs of laboratory testing and vaccination (vaccines and vaccine supplies) to the labor costs increases PH's total by 24% (from \$98,767 to \$122,098) and UW's costs by 36% (from \$117,990 to \$160,664) (Table 1). Examining the material cost of the MMR vaccine doses alone, PH paid for 406 doses costing \$13,058 at CDC contract vaccine prices (246 adult at \$40.00 per dose and 160 child doses at \$20.11 per dose), while UW purchased 581 doses costing \$40,424 (\$69.58 per dose) at private party vaccine prices (all adult doses) (Table 1) (19).

We then examined the seven subcategories of containment and vaccination-related labor activities: communication; case and contact investigation; response planning and coordination; preparing reports; laboratory testing; vaccination clinic planning; and vaccination clinic operations (Table 2). PH and UW accrued almost identical communication costs (including education and media); approximately \$11,000 each, although UW incurred almost twice the number of hours on this subcategory. PH case and contact investigation costs (\$24,256) represented 25% of their total labor costs. UW case and contact investigation costs (\$3,377) were 3% of their total labor costs. PH response planning and coordination costs accounted for only 19% of their total labor costs, but UW response planning and coordination costs accounted for 64% (\$75,493) of UW total labor costs. PH laboratory testing costs of \$20,445 were 21% of their total labor costs. UW did not incur laboratory costs or hours. Vaccination clinic planning costs accounted for 13% of PH total labor costs

** PHSKC took specific steps during the outbreak to ensure time spent on the UW outbreak was differentiated from the larger Washington State outbreak, including estimating a per case investigation cost for UW and determining time spent only on UW communication, outreach, and clinic planning.

and 19% of UW total labor costs. PH incurred \$11,039 administering the vaccination clinics, 11% of PH total labor costs. UW incurred \$3,870 administering the vaccination clinics, 3% of UW total labor costs.

Overall, labor accounted for 77% of total outbreak costs (Table 1). The majority of labor costs were incurred containing the outbreak (77%) (Table 2).

4. Discussion

During February 8–June 6, 2017, 42 mumps cases were identified among UW students, staff, and associated community members. UW and PH incurred costs totaling >\$282,000 and spent almost 2,700 hours responding to and containing the outbreak. Overall, labor was the largest driver of costs in this outbreak accounting for more than three-fourths of the total outbreak costs.

Examining the distribution of hours spent responding to the 2017 UW mumps outbreak between UW and PH, we found that UW and PH incurred roughly equal hours and costs. UW spent more hours for: (1) planning how to respond to the outbreak, (2) preparing for the vaccination clinics, and (3) outreach and education campaign. Many of these hours can be attributed to addressing the legal, medical, and administrative aspects of developing a contract for an additional mass third MMR dose vaccination clinic, including the nuances of an off-label use, which did not occur as the outbreak ended. These hours also might be a result of UW's limited experience with mumps or other infectious disease outbreaks, which is likely true for most universities in the U.S. Universities with a history of prior outbreak response might not incur a portion of the costs required to respond to the current outbreak (i.e., sunk costs). For example, a university with a recent measles or meningitis outbreak might not have mumps experience, but might know the most effective mode of outreach to students (e.g., telephone calls or emails) and thus, might put less effort into other outreach efforts. If UW were to experience another outbreak of mumps or communicable disease, they would be able to benefit from lessons learned during this outbreak response. These lessons learned will assist in developing flexible protocols that will save some of the response costs associated with a future outbreak and serve as a reference for other universities.

UW found four key factors attributed to the successes in their response: a well-established relationship with PHSKC, strong collaboration across the UW units and departments involved in the outbreak control effort, a robust effort to provide communication and education to all UW community members, and effective overall project management. In anticipation of future outbreaks, UW plans to make improvements such as updating and strengthening UW's Communicable Disease Outbreak Management, providing a response blueprint, using a centralized storage system of informational documents for all campus partners to ease access to the information and educational materials, and clearly define the relationship between the outbreak control strategy group and the ongoing UW Advisory Committee for Communicable Diseases. PHSKC determined (1) a pre-existing health emergency response administrative structure at the university integrating PHSKC was extremely important, (2) due to low student concern about preventing mumps illness, uptake

of vaccine was less than anticipated, and (3) the necessity of making vaccination as convenient as possible for students. PHSKC also concluded that a well-established relationship with UW prior to the outbreak facilitated decision-making and implementation of outbreak control measures. Further, both regular weekly meetings between PHSKC and UW and the in-person outreach to the sororities and fraternities aided in information sharing during the outbreak. The context in which the UW mumps outbreak occurred is important to consider when evaluating the cost and hours spent. Washington State was in the midst of its largest mumps outbreak since the late 1970's, accounting for 16% of mumps cases occurring nationally during January–September 2017 (13, 14, 20). Although the mumps cases at UW represented only 6% of the state's total cases, PHSKC and WADOH allocated important resources to assist UW in responding to the outbreak while also responding to the larger Washington State outbreak. PHSKC conducted case/contact investigations and vaccination activities at UW and contributed to the outbreak response with epidemiologists, nurses, administrative professionals, program managers, and immunization managers. All of UW and PH involved staff diverted time from their regular duties to accommodate the outbreak response. Local health departments have been experiencing reductions in resources and do not have “outbreak” budget reserves, therefore, even relatively small outbreaks will likely represent real fiscal challenges (21).

Lastly, UW's outbreak resulted in a relatively small number of cases. Although no direct causation can be drawn, the rapid response by UW and public health agencies and the robust amount of labor allocated to planning and coordination of the outreach and education campaign and vaccination clinics might have contributed to containment of the outbreak. UW's spring break (March 20 – 24) and related student dispersal might have also contributed to curtailing the outbreak at the university. This analysis has several limitations. First, although the majority of costs were captured by UW staff participating in the response, not all participating staff tracked their time and were able to submit hours for this study. Further, no opportunity costs of staff diverted from primary work (or responding to the larger Washington outbreak) to this response were collected. Not including these costs underestimates the total cost and hours spent responding to the outbreak and thus the cost we report represent a lower bound of the total cost of the outbreak. Lastly, the cost of living is significantly higher in the Seattle area than other parts of the U.S. Higher wages likely contribute to a higher total cost.

5. Conclusion

Mumps outbreaks in highly 2-dose vaccinated populations have been increasing across the U.S., triggering discussion of outbreak prevention versus control strategies subject to the competing demands on public health agencies and affected institutions. As one strategy, in October 2017 ACIP recommended a third dose of MMR vaccine for individual protection for persons who are part of a group or population at increased risk for acquiring mumps as determined by public health authorities during an outbreak (6). Persons at increased risk might access vaccination through the routine vaccine delivery systems and a vaccination campaign is not required. At this time, evidence is limited and not sufficient to fully characterize the effect of a third dose of MMR vaccine on reducing the size or duration of an outbreak (6) and thus, prevention and control strategy discussions persist.

As demonstrated in this study, the costs to control a mumps outbreak can be significant for both public health programs and institutions affected. Although the outbreak was relatively small, the economic burden was large. The resources employed likely contributed to: (1) limiting the outbreak and the associated disruption to academic life and (2) possibly benefiting the university in terms of “sunk costs” for future outbreak responses.

Given the limited resources to respond to an outbreak, any discussion or economic analysis to determine optimal response strategies must take into account the cost of responding to an outbreak (as provided in this study), including opportunity costs for public health agencies and affected institutions responding to the outbreak, and identification of strategies to prevent these outbreaks (along with associated costs). The economic burden of the outbreak to UW and the public health authorities highlights the need for further scientific evidence on strategies to prevent or limit the size of outbreaks (such as vaccination versus only case/contact response) and their associated costs. The results from these studies can then be used to evaluate the cost-effectiveness of existing or new intervention strategies.

This study indicates (1) how the cost of responding to a mumps outbreak can burden an affected institution and public health department, (2) the importance of public health department planning for the cost of responding to even modest outbreaks, and (3) the importance of the economics component for future research in determining optimal response strategies to future mumps outbreaks.

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Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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Implications for Policy & Practice

- Mumps outbreaks in highly 2-dose vaccinated populations have been increasing across the United States, triggering discussion of outbreak prevention versus control strategies subject to the competing demands on public health agencies and affected institutions.
- During February 8–June 6, 2017, 42 mumps cases were identified among University of Washington students, staff, and associated community members. The university and public health incurred costs totaling >\$282,000 responding to and containing the outbreak.
- Given the limited resources to respond to an outbreak, any discussion or analysis to determine optimal response strategies must take into account the cost of responding to an outbreak for public health agencies and affected institutions responding to the outbreak, as well as identification of strategies to prevent these outbreaks (along with associated costs).

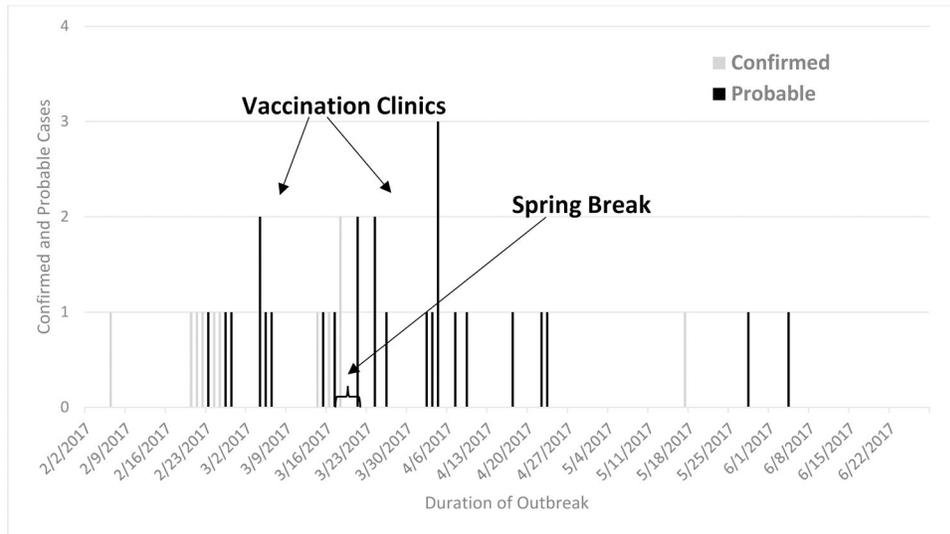


Figure 1: Confirmed and Probable Mumps Cases by onset date of the 2017 UW Mumps Outbreak (February 6 – June 6, 2017).

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Table 1

Estimated resources and costs of the containment and vaccination for the University of Washington mumps outbreak, February 8–June 23, 2017.

Variable	University	Public Health ¹	Total
Vaccination and Containment Labor			
Approximate personnel hours	1,495	1,197	2,692
Vaccine doses	581	406	987
Laboratory Tests	0	142	142
Estimated costs (%)			
Labor	\$117,990 (73)	\$98,767 (81)	\$216,757 (77)
Materials			
Vaccines ²	\$40,424	\$13,058	\$53,482
Vaccination Contractor	\$2,250	N/A	\$2,250
Vaccination supplies and lab ³	N/A	\$10,273	\$10,273
	\$42,674 (27)	\$23,331 (19)	\$66,005 (23)
Total Costs	\$160,664	\$122,098	\$282,762

¹Public health data includes labor and material costs from Public Health—Seattle & King County, Washington State Department of Health, and Minnesota Department of Health combined.

²Cost of vaccine doses ranged from \$20.11 per dose at CDC contract prices purchased by PHSKC to \$69.58 per dose at private party vaccine prices purchased by UW.

³Vaccine supplies totaled \$282.46. Lab tests were \$112.03 per sample for MV PCR tests, \$45.14 per sample for IgM tests, and \$25 per sample for RT-PCR tests.

Table 2

Estimated labor costs and hours by select type and payer for the University of Washington mumps outbreak, February 8–June 23, 2017.¹

	University		Public Health		Total	
	cost (%)	hours (%)	cost (%)	hours (%)	cost (%)	hours (%)
Containment						
Communication/education/media	\$11,351 (10)	196 (13)	\$11,411 (12)	101 (8)	\$22,762 (11)	297 (11)
Case and contact investigation	\$3,377 (3)	38 (3)	\$24,256 (25)	343 (29)	\$27,633 (13)	381 (14)
Response planning/coordination	\$75,493 (64)	850 (57)	\$19,183 (19)	127 (11)	\$94,676 (44)	977 (36)
Prepare reports	\$1,286 (1)	13 (1)	\$0 (0)	0 (0)	\$1,286 (1)	13 (0)
Laboratory	0 (0)	0 (0)	\$20,445 (21)	386 (32)	\$20,445 (9)	386 (14)
Subtotal	\$91,507 (78)	1,096 (73)	\$75,295 (76)	957 (80)	\$166,801 (77)	2,053 (76)
Vaccination						
Vaccination Clinic Planning	\$2,2613 (19)	312 (21)	\$12,433 (13)	122 (10)	\$35,046 (16)	433 (16)
Vaccination Clinic	\$3,870 (3)	88 (6)	\$11,039 (11)	118 (10)	\$14,910 (7)	206 (8)
Subtotal	\$26,483 (22)	400 (27)	\$23,472 (24)	240 (20)	\$49,955 (23)	640 (24)
Total	\$117,990 (100)	1,495 (100)	\$98,767 (100)	1,197 (100)	\$216,757 (100)	2,693 (100)

¹With the exception of laboratory hours, each participant in the outbreak response tracked hours daily by activity in a costing tool customized by activity for each institution (PHSKC and UW). Each respondent from UW supplied a wage, a fringe benefit rate, and an overhead rate. Total daily cost per respondent was calculated by CDC. Each respondent from PHSKC, or a representative of the respondent from PHSKC's accounting department, provided a daily total cost (inclusive of fringe benefits and overhead). Most respondents from UW did not include an overhead rate and some UW respondents were non-benefited employees. The daily cost for each respondent was summed by activity. These activity costs were then grouped into broader activity groups shown in Table 2. For laboratory costs collected from WADOH and MND OH, hours to test a single sample were collected by test type (MV PCR, IgM, RT-PCR), multiplied by the number of samples, and multiplied by the wage plus fringe and overhead. The sum of the total labor cost for the three test types is displayed in Table 2.