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RESEARCH ARTICLE

# Congenital cytomegalovirus surveillance in the United States

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## Abstract

**Background:** Congenital cytomegalovirus (cCMV) is not a nationally notifiable condition, and little is known about how U.S. health departments (HDs) currently conduct cCMV surveillance.

**Methods:** We surveyed U.S. HDs that conduct cCMV surveillance or screening activities identified through a web-based assessment. Meetings were held with each HD to enhance our understanding of survey responses.

**Results:** Ten states are systematically collecting cCMV case data to track cCMV cases during early infancy and to provide resources and services to families. Cases are ascertained using cCMV diagnostic codes, reported diagnosis, or laboratory results. Data elements collected for each case include demographics (all 10 states), clinical signs (8 states), laboratory data (4 states), treatment (4 states), and long-term outcomes (1 state). Annual number of cases reported by HDs ranged from 3 to 47 cases/year in seven states, which was much lower than the expected number of cCMV cases. All 10 HDs have the ability to analyze data collected and four disseminate findings. Major challenges of surveillance reported by HDs were lack of standardized case definitions, personnel constraints, and limited funding.

**Conclusions:** A comprehensive account of cCMV disease burden is severely limited by low case ascertainment and paucity of data on long-term outcomes. A standardized public health case definition for cCMV would improve consistency in measuring disease prevalence across jurisdictions and over time. Surveillance for cCMV has the potential to increase disease awareness and inform strategies to prevent cCMV-associated disabilities.

KEYWORDS

cytomegalovirus, congenital cytomegalovirus, surveillance, United States

## 1 | INTRODUCTION

Congenital cytomegalovirus (cCMV) is the most common infectious cause of birth defects and the leading nongenetic cause of sensorineural hearing loss (SNHL) in children in the United States. The birth prevalence of cCMV in the United States is estimated to be 4.5 per 1,000 live births (Dollard et al., 2021; Fowler et al., 2018). Roughly 10% of infants with cCMV infection have signs at birth, including hepatosplenomegaly, petechiae,

purpura, jaundice, microcephaly, intracerebral calcifications, and chorioretinitis (Rawlinson et al., 2017). The most common cCMV-associated sequalae is SNHL, and other long-term neurodevelopmental sequelae, such as visual impairment, cognitive and motor deficits, may also occur (Dollard et al., 2007).

Laboratory diagnosis of cCMV infection is done by performing polymerase chain reaction (PCR) for CMV DNA or culture on urine, saliva, or less often blood, collected within 3 weeks of life (Rawlinson et al., 2017). Newborns may be tested for cCMV because of clinical signs at birth, maternal history of CMV infection during pregnancy, or after failed newborn hearing screening (Smiljkovic et al., 2020). Some states and hospitals have instituted targeted cCMV screening for those infants who fail the newborn hearing screening. Universal newborn cCMV screening, which includes testing all newborns within 21 days of life, to date has mostly been done in research settings. The province of Ontario, Canada, implemented universal cCMV screening of newborns in July 2019 as part of an expanded hearing risk factor screening program (Newborn Screening Ontario, 2022). In the United States, Minnesota plans to screen all newborns for cCMV; the recommendation by the Advisory Committee on Heritable and Congenital Disorders was approved in 2022 (Minnesota Department of Public Health, 2022). In the absence of universal screening, most infants with cCMV infection remain undiagnosed. While an early diagnosis of cCMV may offer opportunities for early detection and intervention for infants at increased risk of SNHL and neurodevelopmental delays, there are concerns of overtreatment with antivirals. Currently, antiviral treatment with valganciclovir should be limited to infants with moderately to severely symptomatic cCMV disease (Rawlinson et al., 2017).

Surveillance for cCMV may be conducted to monitor trends in disease prevalence and the use of antivirals, and identify groups at higher risk of cCMV. Moreover, cCMV surveillance may provide opportunities to increase disease awareness and assess how often infants with cCMV are identified and connected to services. In countries such as Australia, Belgium, the United Kingdom, Ireland, Spain and Canada, cCMV surveillance has been conducted for a range of 2–23 years. In these countries, major challenges of cCMV surveillance were underdiagnosis and underreporting, as well as heterogeneity in cCMV case classification, underrepresentation of asymptomatic cases, and incomplete birth and long-term follow up data (Bartlett et al., 2018; Keymeulen et al., 2021; Townsendet al., 2011; Vaudryet al., 2014; Villaverde et al., 2022). In the United States, the National Congenital CMV Disease Registry received cCMV case reports voluntarily from large referral centers in 17 U.S. states and Ontario, Canada during 1990–1995, with the prevalence of symptomatic cCMV disease ranging from 0.5 to 13.6 cases per 10,000 live births during the first 3 years (Istas et al., 1995). However, cCMV is not a nationally notifiable condition in the United States and little is known about how U.S. health departments (HDs) currently conduct cCMV surveillance activities. Here, we summarize the status of cCMV surveillance in the U.S., discuss challenges and potential ways to enhance case ascertainment and data collection, including plans for piloting cCMV surveillance in a population-based longitudinal mother–infant surveillance system.

## 2 | METHODS

We assessed the extent to which states have implemented cCMV surveillance, defined as the "ongoing, systematic collection, analysis, [...] and dissemination of data [...] for use in public health action to reduce morbidity and mortality and to improve health", in the United States (German et al., 2001). To identify states which have implemented surveillance activities or cCMV screening, we reviewed all 50 state HD websites from November to December 2021, and summarized information on cCMV case ascertainment methods (e.g., case definition, reporting mechanisms, presence of screening), if available. From January to June 2022, we surveyed the HDs identified to collect additional information on cCMV surveillance goals, personnel, funding, case ascertainment methods, data sources, case definitions, data elements, data analysis, dissemination of findings, and challenges (Appendix S1). Based on the survey responses, we developed semi-structured interview guides for a virtual meeting with each HD to expand upon the cCMV surveillance infrastructure and processes reported in survey responses, discussing case ascertainment methods, data flow, and laboratory criteria in depth. Staff from various HD programs (e.g., birth defects, newborn screening, early hearing detection and intervention, infectious diseases, and laboratory) and their external partners (e.g., clinicians, academic partners) involved in cCMV surveillance activities participated in the virtual meetings. This activity was reviewed by Human Subjects Coordinator for the National Center for Immunization and Respiratory Diseases at the Centers for Disease Control and Prevention (CDC) and was designated a nonresearch program evaluation.

Beyond describing cCMV surveillance activities, we attempted to understand the level of ascertainment of cCMV cases in each state. We asked HDs to provide the annual number of cCMV cases reported, which we compared with the expected number of cCMV cases. We

calculated the average annual number of expected cCMV cases based on the birth cohort for each state during 2016–2020 (National Center for Health Statistics, 2022) assuming the prevalence of cCMV infection was uniformly 4.5 per 1,000 live births (Dollard et al., 2021; Fowler et al., 2018).

## 3 | RESULTS

Out of the 50 states assessed during the web-based review, cCMV surveillance or screening activities were identified in 13 states (Colorado, Connecticut, Delaware, Georgia, Illinois, Iowa, Michigan, New Jersey, New York, Oklahoma, Texas, Utah, and Virginia). Ten out of 13 states both completed the electronic survey and participated in virtual meetings; two states only completed the survey (though one submitted responses by email), and one state only participated in the virtual meeting. From our assessment, we found that three states (Texas, Georgia, and Iowa) do not systematically collect cCMV data. Texas captures cCMV cases if another reportable birth defect is first identified in an infant, and Georgia and Iowa capture some cCMV cases without a set reporting infrastructure, leading to inconsistent data collection over time. Universal cCMV screening in Minnesota and targeted cCMV screening in three additional states (Florida, Kentucky, and Maine) have been approved but neither screening nor surveillance (approved in Florida and Maine) had yet been implemented by June 2022. Thus, this assessment summarizes cCMV surveillance activities in 10 states that had ongoing and systematic collection of cCMV case data: Colorado, Connecticut, Delaware, Illinois, Michigan, New Jersey, New York, Oklahoma, Utah, and Virginia, as of June 2022 (Table 1).

### 3.1 | Surveillance for cCMV

In states collecting cCMV case data, the population monitored includes either all newborns or a subset of newborns, such as those who failed newborn hearing screening. All 10 states collect state-wide cCMV case data, with New Jersey being the first state to implement systematic data collection for cCMV, in 1985 (Table 1). Over the next 9 years, three additional states initiated birth defects surveillance systems that included cCMV on the list of reportable birth defects. In 2003, the addition of cCMV to the Communicable Disease Rule in Delaware mandated the reporting of infants with laboratory confirmed cCMV to the HD by hospitals, healthcare providers, and laboratories. In 2011 and 2016, Michigan and New York, respectively, initiated reporting of cCMV cases, identified through diagnostic codes, to the birth defects registry. Utah, Connecticut, and Virginia mandated the reporting of infants with laboratory confirmed cCMV identified by targeted screening beginning in 2013, 2016, and 2020, respectively. In 2015, Utah also added cCMV to the Communicable Disease Rule, mandating the reporting of all cCMV laboratory results in infants 12 months of age or less. Then, in 2019, Utah expanded its targeted cCMV screening to include infants with higher risk of cCMV, that is, infants with maternal history of CMV infection during pregnancy, or presenting with select clinical, laboratory, or brain imaging findings at birth (Table 1).

The three main goals of cCMV surveillance as reported by HDs were to monitor trends in cCMV prevalence, to provide resources and connect families to services, and to track compliance of targeted cCMV screening. Resources and services provided by states to families with infants with cCMV include educational materials (Virginia), case management services (Illinois, New Jersey, Utah), and referral to health experts (Colorado, Virginia, Utah).

Hospitals are the primary reporting sources for cCMV cases; other major reporting sources include providers and laboratories (Table 2). Some HDs also ascertain cCMV cases from these and additional data sources. However, a cCMV case definition is not yet standardized in the U.S. Typically, the criteria for case reporting or ascertainment include cCMV diagnostic codes (e.g., the International Classification of Diseases, Tenth Revision, Clinical Modification, cCMV diagnostic code [P35.1]), reported diagnoses (e.g., checked box on a vital record, reference in open text box on referral form), or laboratory results (Table 1).

Two states primarily use diagnostic codes without laboratory results (Table 1). In Oklahoma, HD officials review multiple data sources (e.g., electronic health records, vital records, newborn screening reports) to identify cases using cCMV diagnostic codes, while in Michigan the HD is notified of cases based on cCMV diagnostic codes. In four states, the ascertainment or notification of cases is based on either diagnostic codes or reported diagnoses without laboratory results (Table 1). In Illinois and New York, cases with cCMV diagnostic codes or reported diagnoses are notified to the birth defect surveillance system. In Colorado, cases with a reported diagnoses of cCMV are ascertained from vital records, pathology reports, clinical reports, and cytogenetic laboratory referral forms, in addition to cases with a cCMV diagnostic code which are notified to the birth defects surveillance system. In New Jersey, cases with

**TABLE 1** States conducting cCMV surveillance activities in the United States as of June 2022 listed according to implementation date

| State | Implementation of surveillance activities | Method of ascertainment/ reporting | Laboratory testing method, specimens, and timing | Reporting interval | cCMV targeted screening | Managing program |
|---|---|---|---|---|---|---|
| New Jersey | 1985 | Diagnostic codes[a] or reported diagnosis[b] | — | — | No | Birth defects and early hearing detection and intervention program |
| Colorado | 1989 | Diagnostic codes[a] or reported diagnosis[b] | — | 120 days from hospital discharge | No | Birth defects program |
| Illinois | 1989 | Diagnostic codes[a] or reported diagnosis[b] | — | 7 days from hospital discharge | No[c] | Birth defects program |
| Oklahoma | 1994 | Diagnostic codes[a] | — | — | No | Birth defects program |
| Delaware | 2003 | Laboratory positive cases | PCR: Saliva or blood ≤90 days of life | 48 hours | No | Communicable disease program |
| Michigan | 2011 | Diagnostic codes[a] | — | — | No | Birth defects program |
| Utah | 2013 | Laboratory positive cases | PCR: Dried blood spot or urine -- PCR: Saliva (screening) PCR: Urine (confirmation) ≤21 days of life | 10 days | Yes[d] | Early hearing detection and intervention program |
| Connecticut | 2016 | Laboratory positive cases | PCR: Saliva or urine Culture: Urine ≤21 days of life | No set interval: As soon as possible | Yes[e] | Early hearing detection and intervention program |
| New York | 2016 | Diagnostic codes[a] or reported diagnosis[b] | — | 30 days from hospital discharge, but 10 days preferred | Yes[e] | Birth defects program |
| Virginia | 2020 | Laboratory positive cases | PCR: Saliva (screening) PCR: Urine (confirmation) ≤21 days of life | — | Yes[e] | Early hearing detection and intervention program |

Abbreviation: cCMV, congenital cytomegalovirus.

[a]International Classification of Diseases, Tenth Revision, Clinical Modification, cCMV diagnostic code (P35.1).

[b]Case reported based on a checked box on a vital record, reference in open text box on referral form, or other clinical report without a lab record.

[c]cCMV testing is discussed with parents of newborns who do not pass the newborn hearing screening.

[d]Targeted screening among infants who do not pass the newborn hearing screening since 2013, and infants at higher risk of cCMV since 2019; Infants with higher risk of cCMV include infants presenting with one of the following: clinical (e.g., abnormal head size, intrauterine growth restriction, petechiae, hepatomegaly, splenomegaly), laboratory (e.g., thrombocytopenia, elevated liver enzymes) or brain imaging (e.g., intracranial calcifications, leukomalacia, polymicrogyria, lissencephaly, pachygyria, schizencephaly); mother positive for CMV infection during pregnancy.

[e]Targeted screening among infants who do not pass the newborn hearing screening.

**TABLE 2** Data elements collected for cCMV cases, analysis and dissemination by state

| State (year of implementation) | Case reporting source | Data elements collected | | | | | | Data analysis Capacity[a] | Data Disseminated[b] |
|---|---|---|---|---|---|---|---|---|---|
| | | Demographics | Clinical Signs[c] | Laboratory | Treatment | Long-term outcomes | Maternal | | |
| New Jersey (1985) | Hospitals, providers | X | X | | | | | X | |
| Colorado (1987) | Hospitals, Medicaid, vital records, laboratories[d], pathology reports | X | | | | | X | X | |
| Illinois (1989) | Hospitals | X | X | | X | | X[e] | X | X |
| Oklahoma (1994) | Health department officials search for cases: Hospitals, providers, vital records, newborn hearing screening, medical examiner | X | X | | | | X[e] | X | |
| Delaware (2003) | Laboratories, providers | X | X | X | | | X[e] | X | |
| Michigan (2011) | Hospitals, providers | X | X | | | | X | X | X |
| Utah (2013) | Hospitals, laboratories, providers, public | X | X | X | X | X | X[e] | X | X |
| Connecticut (2016) | Hospitals | X | X | X | X | | X | X | |
| New York (2016) | Hospitals | X | | | | | X | X | |
| Virginia (2020) | Hospitals, laboratories providers | X | X | X | X | | X | X | X |
| **Total** | | **10** | **8** | **4** | **4** | **1** | **9** | **10** | **4** |

Abbreviation: cCMV, congenital cytomegalovirus.

[a]Includes states who showed the capacity to analyze birth prevalence.

[b]Includes states who developed summaries, reports, or visualizations that they reported sharing.

[c]States collecting data on clinical signs do so through review of electronic health records, an electronic reporting form, or follow-up interviews with parents.

[d]Reportable conditions ascertained by HD from laboratory reports if listed in the reason for referral, laboratory results not collected.

[e]Maternal infection data collected along with maternal demographics.

cCMV diagnostic codes or reported diagnoses are notified to the birth defects surveillance system, immunization information system, or vital statistics system.

In four states, cCMV cases are reported based on laboratory testing, most commonly using PCR tests of urine or saliva specimens collected within 21 days of life (Table 1). Delaware includes specimen collection within 90 days of life, limiting the specificity of the diagnosis. Connecticut accepts cultures performed on urine in addition to PCR tests of saliva or urine. Utah and Virginia require PCR tests of urine for confirmation of cases that are initially positive by PCR on saliva. In Utah, a cCMV case may also be confirmed by a positive PCR test on dried blood spot, which is used to investigate cases of delayed-onset SNHL.

Congenital CMV surveillance activities are led by various and, in some states, multiple units within a HD (Table 1). Personnel contribute part of their time to cCMV activities in all states except Virginia, which has two full-time staff members assigned to cCMV surveillance. Funding available for cCMV surveillance is allocated from funds not specifically designated for cCMV. Two major challenges for surveillance and follow-up activities are personnel constraints and limited funding, as reported by three HDs. Additional reported challenges included lack of a standardized case definition, complex and siloed data systems, incomplete reporting, and delays in receiving case data. When surveyed on the priority given to the development of a standardized case definition, HD personnel largely ranked this as a high priority.

## 3.2 | Data collection, analysis, and dissemination of findings

Data elements collected for each case vary by state (Table 2). All states collect infant demographic data, but laboratory data are only systematically collected by states requiring laboratory testing for case reporting (Connecticut, Delaware, Utah, and Virginia). States collecting data on clinical signs do so through review of electronic health records (EHRs) (Delaware, Oklahoma, and Utah), an electronic reporting form (Connecticut, Illinois, and Michigan, New Jersey), or follow-up interviews with parents (Virginia). Maternal information, primarily demographics, is collected by most states; only Delaware, Illinois, Oklahoma, and Utah collect information on history of maternal CMV infection during pregnancy. Utah periodically examines EHR data to track long-term outcomes of children identified with cCMV. Two states, Utah and Connecticut, reported evaluating data quality, specifically data elements that impact case classification. All 10 HDs have the ability to analyze data collected and four disseminate findings, primarily trends in cCMV prevalence (Table 2). Across seven states that provided cCMV case data, the annual number of cases reported by HD range from 3 to 47 cases per year. The average

**TABLE 3** Annual number of expected and reported cCMV cases by state

| State (year of implementation) | Total number of live births (2016–2020)[a] | Average annual number of expected cCMV cases[b] | Annual number of reported cCMV cases[c] (%)[d] | Period for reported cCMV cases |
|---|---|---|---|---|
| New Jersey (1985) | 502,659 | 452 | 3–14 (0.7–3.1) | 2010–2021 |
| Colorado (1989) | 318,243 | 286 | 14–15 (4.9–5.2) | 2016–2021 |
| Illinois (1989) | 722,076 | 650 | 46 (7.1) | 2020 |
| Oklahoma (1994) | 249,372 | 224 | 5–20 (2.2–8.9) | 1994–2019 |
| Delaware (2003) | 53,422 | 48 | <10 (<20.8) | 2016–2021 |
| Michigan (2011) | 546,733 | 492 | 11–46 (2.2–9.3) | 2000–2019 |
| Utah (2013) | 238,786 | 215 | 7–28 (3.3–13.0) | 2013–2021 |
| Connecticut (2016) | 173,679 | 156 | <11 (<7.1) | 2021 |
| New York (2016) | 1,121,135 | 1,009 | N/A | N/A |
| Virginia (2020) | 494,872 | 445 | 24–36 (5.4–8.1) | 2020–2021 |

Abbreviation: cCMV, congenital cytomegalovirus.

[a]Natality Records 2016–2020, as compiled from data provided by the vital statistics jurisdictions through the Vital Statistics Cooperative Program (National Center for Health Statistics, 2022).

[b]Average annual number of expected cCMV cases was based on a birth prevalence of 4.5 cCMV cases per 1,000 live births.

[c]Range of cases reported per year for length of surveillance system unless otherwise specified.

[d]Percent of expected, calculated based on the average annual number of expected cCMV cases for the 2016–2020 live birth cohort.

annual number of reported cCMV cases was much lower than the expected number of cCMV cases (Table 3).

## 4 | DISCUSSION

In this assessment, we found that only 10 of 50 states in the U.S. systematically collect cCMV case data. Moreover, case ascertainment methods vary, a standardized case definition is lacking, only four states require laboratory confirmation, and data collection is limited, particularly for long-term outcomes of infants with cCMV. In general, cCMV surveillance is conducted to track cCMV cases during early infancy and to provide resources and services to families. A comprehensive account of state-specific cCMV disease burden is limited by low case ascertainment and challenges in collecting data on long-term outcomes.

As identified in the assessment, cCMV case inclusion criteria and ascertainment methods differ by state with some requiring laboratory confirmation and others relying only on reported diagnosis or cCMV diagnostic codes. Studies using diagnostic codes recorded in hospital discharge or administrative data estimate prevalence of cCMV to range from 0.6 to 3.8 per 10,000 infants, an order of magnitude lower than the birth prevalence found in universal screening studies (Grosse et al., 2021). While administrative data have been used to monitor national trends in cCMV prevalence and prescription of antivirals, validation studies assessing the sensitivity, specificity, and positive predictive value of cCMV diagnostic codes are lacking (Grosse et al., 2021). A study using data from a large U.S. EHR database found that only 1 in 10 infants with a laboratory-confirmed diagnosis of cCMV received a diagnostic code for cCMV infection, with sensitivity varying by U.S. region (Campione et al., 2021). In Michigan, a HD validation study with comprehensive review of health records when available found that 84% of cCMV cases reported to the state birth defects registry and 72% of those ascertained through review of birth, death and hospital discharge data during 2004–2011 were true cCMV cases; 65% of the true cCMV cases had been reported to the birth defects registry (Quarshie et al., 2016). States collecting cCMV case data through diagnostics codes may be uniquely positioned to conduct formal validation studies by examining EHRs and laboratory reports to assess whether cases identified using diagnostic codes had laboratory confirmation and clinical signs of cCMV disease at birth. Nonetheless, validation studies for cCMV diagnostic codes would not sufficiently inform the extent infants with cCMV cases are identified, which would require a reliable estimate of true birth prevalence.

States incorporated cCMV surveillance into established systems, such as the birth defects registry, Early Hearing Detection and Intervention (EHDI), or communicable diseases; however, these systems may not be flexible enough to incorporate cCMV-specific data elements, such as clinical signs, laboratory results, maternal information, or longitudinal follow-up data on long-term outcomes. Additionally, cCMV surveillance activities require complex coordination between HD units (e.g., birth defects, newborn screening, EHDI, communicable diseases), and linkage of various data sources to identify, track, and collect data on short- and long-term outcomes of infants with cCMV. While most states collect some data on clinical signs at birth, only Utah collects follow-up data on long-term outcomes of children with cCMV. Utah receives the majority of cCMV test results through electronic laboratory reports as a part of the Communicable Disease Rule, after which confirmed cases are both automatically transmitted to the EHDI surveillance system and manually entered into a cCMV database. Congenital CMV-specific data elements ascertained through medical record abstraction or through data requests to the reporting hospital are then incorporated into the cCMV database. Follow-up data on long-term outcomes are manually abstracted for all confirmed cases by HD personnel ad hoc. Data collection including demographic variables, such as maternal age and race/ethnicity, and neonatal and neurodevelopmental outcomes of infants with cCMV will be important to identify groups at higher risk of cCMV-associated disabilities and inform potential prevention strategies. Therefore, assessing the feasibility of systematic data collection and linkage from different sources will be important for determining key data elements in an effort to standardize cCMV surveillance.

Currently, cCMV surveillance relies primarily on passive reporting from hospitals, providers, and laboratories. Connecticut, Utah, and Virginia primarily capture cCMV cases identified through targeted screening. Of note, Utah added cCMV to the Communicable Disease Rule in 2015, 2 years after implementing targeted cCMV screening for infants who do not pass the newborn hearing assessment, which was expanded to include infants with other risks for cCMV in 2019, primarily those with NICU stays. Alternatively, New York and Iowa, which passed legislation on targeted cCMV screening in 2018 and 2017, have not established direct reporting of screening-detected cases. New York added cCMV as a reportable condition to the birth defects registry in 2016, using diagnostic codes for cCMV to identify cases, whereas Iowa does not have the authority or resources for cCMV reporting. In 2022, Minnesota approved the future addition of cCMV to the state universal newborn screening panel, Florida and Maine passed legislation for targeted cCMV

screening and reporting, and Kentucky passed legislation for targeted screening only. Screening for cCMV may provide opportunities for enhanced surveillance. However, jurisdictions may need additional resources and updated authority for case reporting and data collection. Moving forward, identifying ways to ensure integration of newborn screening with surveillance and follow-up could optimize use of public health resources. Variable case ascertainment methods or screening strategies produce additional challenges regarding the certainty of diagnosis and spectrum of disease captured. Therefore, consensus on cCMV case definitions used for public health surveillance will be important for consistency in measuring disease prevalence across jurisdictions and over time.

This assessment has several limitations. For a HD to be contacted for the survey, information about the surveillance system or cCMV screening had to be available online. We may have missed states with cCMV surveillance if it was not included on their state website or may not have identified activities due to heterogeneity in managing programs across states. In addition, multiple units within a HD (e.g., communicable disease, birth defects, EHDI, newborn screening) can be involved in cCMV activities. While our assessment attempted to coordinate with all relevant departments, not all may have been able to participate in the survey and/or interview. Finally, our assumptions to estimate the expected number of cCMV cases for each state were based on data from large U.S. studies, but state-specific cCMV prevalence may vary widely depending on the population characteristics.

This project assessed cCMV surveillance conducted by HDs but did not include cCMV activities led by individual hospitals or academic institutions. In Texas, for example, cases of cCMV, such as those referred to the CMV Clinic at Texas Children's Hospital, have been voluntarily reported to the cCMV registry at the Baylor College of Medicine to describe trends over time and characteristics of infants with cCMV (Department of Pediatrics, 2021). Across the U.S., standardized data reported by >750 hospitals to the Vermont Oxford Network allowed the description of CMV and other infections among very low birth weight (VLBW) and/or preterm infants during 2018–2020 (Edwards et al., 2022). In California, similar data from both VLBW and other eligible live-born infants hospitalized in neonatal intensive care units (NICUs) have been used to describe trends in CMV infection in these populations during 2005–2016 (Tran et al, 2020). Furthermore, linked data from the NICUs and the California High-Risk Infant Follow-up Program can be used to assess neurodevelopmental outcomes up to 3 years of age among eligible infants with CMV infection (Lanzieri et al., 2022). Cases identified in these populations might overrepresent infants with more severe disease and outcomes in comparison to those identified by newborn screening. Nevertheless, the strengths and limitations of systems that were either specifically developed or leveraged to provide data on cCMV among infants may be informative to the wider implementation of cCMV surveillance by HDs. Engagement among HD personnel and those in health care and academic institutions may provide opportunities for improving case ascertainment, data collection, analysis and interpretation, and dissemination of findings to inform programs and policies, including quality care improvement.

In 2019, CDC, in collaboration with state, local, and territorial health departments, implemented a population-based mother–infant-linked longitudinal surveillance, the Surveillance for Emerging Threats to Mothers and Babies Network (SET-NET), which collects data on infectious disease threats, including congenital syphilis, hepatitis C, and COVID-19 (National Center on Birth Defects and Developmental Disabilities, 2022). HDs obtain data for mother–infant pairs through linkages with relevant data sources (e.g., vital statistics, health department investigations, and case reporting) and data abstraction, retrospectively or prospectively, from medical or laboratory records. SET-NET constitutes an adaptable mother–infant surveillance network, with general variables consistent across conditions, as well as modular data elements that allow for expansion to novel conditions (Woodworth et al., 2021). Most recently, SET-NET data were used to describe SARS-CoV-2 testing patterns and positivity rates among neonates born to pregnant persons with SARS-CoV-2 infection during pregnancy, as well as infant outcomes through 6 months of age (Olsen et al., 2022; Gosdin et al., in press). During 2022–2023, CDC will fund five jurisdictions (Iowa, Minnesota, New Jersey, New York, and Utah) to pilot cCMV surveillance through SET-NET. The aims are to inform methods for case ascertainment and assess accuracy of different case definitions and feasibility of data collection. With selected jurisdictions in various stages in their cCMV surveillance programs, with or without cCMV screening, cross-collaboration may provide a forum to share lessons learned from the pilot and from more mature programs to guide other jurisdictions as they implement or strengthen cCMV surveillance in the future. Additional collaboration with clinical sites will be important to enhance surveillance, validate diagnostic codes, and identify training needs, especially when the adoption of standardized case definition for cCMV becomes imminent.

Although cCMV is the most common congenital infection in the United States, state-specific prevalence is unknown. Consistent with findings from other countries, in most states providing data, the reported number of

cCMV cases was much lower than the expected number of cCMV cases (Bartlett et al., 2018; Keymeulen et al., 2021; Townsend et al., 2011; Vaudry et al., 2014; Villaverde et al., 2022). In the absence of universal screening, the underdiagnosis and underreporting of infants with cCMV cases is expected. Testing of stored newborn blood spots of >30,000 children up to 6 years of age in the Netherlands found 156 children with cCMV, of whom only 4 (3%) had been previously diagnosed with cCMV (Korndewal et al., 2016). With a growing number of states implementing targeted or universal cCMV screening, there will be opportunities for enhanced cCMV surveillance and additional challenges. A standardized public health case definition for cCMV is important for consistency in measuring disease prevalence across jurisdictions and over time (Sontag et al., 2018). In addition, documenting case ascertainment methods and the source population will enhance understanding of cCMV prevalence. Furthermore, cCMV surveillance might increase disease awareness and inform potential strategies (e.g., vaccination, behavioral interventions, early intervention, targeted communication for disproportionally affected populations, and antiviral treatment) to prevent cCMV-associated disabilities.

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None of the authors have any conflict of interest, financial or otherwise.

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Research data are not shared.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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