HHS Public Access

Author manuscript

J Correct Health Care. Author manuscript; available in PMC 2015 October 15.

Published in final edited form as:

J Correct Health Care. 2014 October ; 20(4): 292–301. doi:10.1177/1078345814541535.

Challenges with controlling varicella in prison settings: Experience of California, 2010–2011

Jessica Leung, MPH[1], **Adriana S. Lopez, MHS**[1], **Elena Tootell, MD**[2], **Nikki Baumrind, PhD, MPH**[2], **Janet Mohle-Boetani, MD, MPH**[2], **Bruce Leistikow, MD, MS**[2], **Kathleen H. Harriman, PhD, MPH, RN**[3], **Christopher P. Preas, PHM**[3], **Giorgio Cosentino, PHM**[3], **Stephanie R. Bialek, MD, MPH**[1], and **Mona Marin, MD**[1]

[1]National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, Atlanta, GA, USA

[2]California Correctional Health Care Services, Elk Grove, CA, USA

[3]California Department of Public Health, Los Angeles, CA, USA

Abstract

We describe the epidemiology of varicella in one state prison in California during 2010–2011, control measures implemented, and associated costs. Eleven varicella cases were reported, 9 associated with 2 outbreaks. One outbreak consisted of 3 cases and the second consisted of 6 cases with 2 generations of spread. Among exposed inmates serologically tested, 98% (643/656) were VZV sero-positive. The outbreaks resulted in >1,000 inmates exposed, 444 staff exposures, and > $160,000 in costs. We documented the challenges and costs associated with controlling and managing varicella in a prison setting. A screening policy for evidence of varicella immunity for incoming inmates and staff and vaccination of susceptible persons has the potential to mitigate the impact of future outbreaks and reduce resources necessary for managing cases and outbreaks.

Keywords

Varicella; chickenpox; prison; outbreak; costs

Correspondence: Jessica Leung, Centers for Disease Control and Prevention, National Center for Immunization and Respiratory Diseases, 1600 Clifton Rd, Mail-Stop A-34, Atlanta, GA 30333, Phone: 404-639-6067, Fax: 404-315-2486, JLeung@cdc.gov.

Potential Conflicts of Interest:
Jessica Leung, Centers for Disease Control and Prevention: *No conflict*
Adriana S. Lopez, Centers for Disease Control and Prevention: *No conflict*
Elena Tootell, CA Department of Corrections and Rehabilitation: *No conflict*
Nikki Baumrind, CA Correctional Healthcare Services: *No conflict*
Janet Mohle-Boetani, CA Correctional Healthcare Services: *No conflict*
Bruce Leistikow, CA Correctional Healthcare Services: *No conflict*
Kathleen Harriman, CA Department Public Health: *No conflict*
Chris Preas, CA Department Public Health: *No conflict*
Giorgio Cosentino, CA Department Public Health: *No conflict*
Stephanie R. Bialek, Centers for Disease Control and Prevention: *No conflict*
Mona Marin, Centers for Disease Control and Prevention: *No conflict*

Disclosure: The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention or the California Correctional Health Care Services.

Introduction

Varicella-zoster-virus (VZV) is a highly contagious virus, with secondary attack rates in households reaching 65%–90% (Marin, Guris, Chaves, Schmid, & Seward, 2007). VZV is transmitted from person to person by direct contact, inhalation of viral particles from the skin lesions of acute varicella or zoster, or infected respiratory tract secretions that have been aerosolized (Marin et al., 2007). The average incubation period is 14–16 days and patients with varicella are contagious 1–2 days before rash onset until all lesions are crusted (Marin et al., 2007). After primary infection, VZV remains dormant in the sensory-nerve ganglia and may reactivate at a later time to cause herpes zoster. Exposure to persons with either varicella or herpes zoster can lead to varicella in susceptible persons. Adults, immunocompromised persons, and pregnant women are at increased risk of severe varicella. A routine varicella vaccination program has led to substantial decreases in varicella cases, hospitalizations, and deaths in the United States (Marin et al., 2007).

Residents of congregate settings are at higher risk of VZV transmission. Varicella outbreaks have been reported in residential settings including prisons, adult residential facilities, hospitals, and army barracks (de Valliere et al., 2011; Enright, Mc Mahon, & Washington, 2006; Faoagali & Darcy, 1995; Getaz et al., 2010; Grossberg et al., 2006; Leung et al., 2010; Levy et al., 2003; Longfield, Winn, Gibson, Juchau, & Hoffman, 1990; Noorda & Hoebe, 2004; Valdarchi et al., 2008; Wood & Stevenson, 2004; Zimmerman et al., 2003). In prisons, factors identified as contributing to transmission of infectious diseases include crowding, constant close contact, and movement of inmates into and between prisons (Bick, 2007; “Federal Bureau of Prisons: Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline,” 2011). VZV can be introduced into prisons by staff, visitors, or prisoners with varicella or herpes zoster. Because inmates are adolescents or adults and have a higher prevalence of HIV infection than the general population (Bick, 2007), they are at higher risk of severe varicella.

Management of varicella cases and outbreaks in prison settings can lead to significant costs and can be disruptive (Breuer, 2004). In 2009, 1.5 million persons were living in state or federal prisons in the United States, a considerable population at increased risk of infectious diseases (“Glaze LE. Bureau of Justice Statistics: Correctional Populations in the United States, 2009. Washington, DC: US Department of Justice; 2010. Available at http://bjs.ojp.usdoj.gov/content/pub/pdf/pim09st.pdf “). As of December 2010, the in-prison population in California was 162,821 and prisons were operating at 170% of housing capacity (“California Department of Corrections and Rehabilitation. Office of Public and Employee Communications. Corrections-Year at a glance-Fall 2011,”). Varicella is the most common vaccine-preventable disease in California state correctional institutions, with approximately 40 inmate cases reported annually (*Mohle-Boetani J. Cost-benefit of varicella prevention in state prisons in California. In: Program and abstracts of the 2011 Academic and Health Policy Conference on Correctional Health (Boston). Worcester, MA: University of Massachusetts Medical School. Available at:* http://www.correctionalhealthconference.com/2011-presentations#seminars). To better understand the burden of varicella in prison settings, we described the epidemiology of varicella in one

state prison (Prison A) in California during 2010–2011, control measures implemented, and associated costs.

Methods

Setting

Prison A has approximately 2,000 staff, including 1,228 non-healthcare, 377 healthcare, and 453 support staff. Approximately 5,000 male inmates are housed in Prison A, half of whom are transitional inmates who are housed temporarily for an average of 6 months-2 years. Transitional inmates first enter a reception center and are housed separately from permanent inmates. Prison A consists of segregated cell blocks, also called units, which differ in housing arrangement (dormitory-style, double-cell, single-cell), level of inmate participation in work, educational, and recreational activities, and visitation rights based on the level of security required to guard the inmates. Prison A receives an average of 400 new inmates weekly, makes 300 bed moves daily, and operates at approximately 200% of capacity. Inmates may interact with each other within the prison through dining, activities, work, and bed moves; they may have contact with the community through interactions with staff, visitors, and transfer to court. Based on voluntary screening, it is estimated that approximately 2% of inmates in Prison A are potentially immunosuppressed, primarily due to HIV infection (~85%). Prison A has 7 medical clinics that provide non-urgent and urgent medical care, and 3 airborne infection isolation rooms.

Epidemiologic investigation

A varicella case was defined as a diagnosis of varicella in an inmate made by a healthcare provider between 1/1/10–12/31/11. A varicella outbreak was defined as ≥3 varicella cases over a 2-month period. For laboratory confirmation of cases, blood and lesion specimens were sent to a commercial laboratory for PCR, viral culture, or IgM testing. Healthcare staff in Prison A collected demographic and clinical information on varicella case-patients.

Inmate exposure was defined as direct contact with nasopharyngeal secretions or skin lesions, face-to-face interactions, or sharing indoor airspace (within approximately 3 feet of an index case) for ≥1 hour during a varicella case's infectious period (defined as 2 days before rash onset until isolation). For inmates living in settings where they had frequent interaction with other inmates in their unit, all were considered exposed if a varicella case was identified in the unit, whereas for those living in a single-cell unit who had limited interaction with other inmates, only inmates living 5 cells left and right of the varicella case-patient, and 11 cells on the floors directly above and below the varicella case-patient (an area 66 feet wide x 24 feet high) were considered to have shared indoor space and to have been exposed. A conservative definition of exposure was used because some studies have found that airborne transmission of VZV through ventilation systems is possible (Gustafson et al., 1982; Leclair, Zaia, Levin, Congdon, & Goldmann, 1980); additionally, cells have barred doors that permit airflow from surrounding cells. Healthcare staff used custody movement sheets, databases, and rosters of inmates in transport buses, classrooms, chapels, visitor centers, dining halls, parole hearing sites, and work areas to identify possible exposures.

Exposed inmates were assessed for evidence of immunity to varicella. In 2010, assessment was based on the country and year of birth with inmates born in the United States before 1980 considered to have evidence of immunity per ACIP criteria (Marin et al., 2007). An inmate's self-reported history of varicella was not considered evidence of immunity. Inmates born outside the United States, or US-born after 1979 were assessed using serology. In 2011, all exposed inmates were tested for laboratory evidence of immunity. Testing was performed at a commercial or state public health laboratory. Documentation of varicella vaccination status was not available.

Varicella outbreak cost assessment

Data were collected on costs related to staff hours needed to manage varicella cases and exposed inmates, isolation of varicella case-patients, collection and laboratory testing of specimens, and vaccination of susceptible inmates.

Approval from an institutional review board was not required because data was collected as part of a public health response.

Results

I. Epidemiologic Investigation

Epidemiology of varicella cases and outbreaks—A total of 11 varicella cases were reported in Prison A during 2010–2011; 9 were associated with 2 outbreaks. None of the 11 varicella case-patients were immuncompromised or had any varicella-related complications. Characteristics of cases are described in Table 1.

One outbreak occurred in 2010 and comprised 3 co-incident case-patients (rash onsets: 1/16/10–1/23/10), all of whom were housed in different units. The case-patients had no known contact with each other or any visitors during 3 weeks before rash onset; it could not be determined whether any staff had contact with all 3 cases. Two cases occurred among inmates living in a single-cell unit (47 year-old and 19 year-old), and one case occurred in an inmate (24 year-old) who lived in a dormitory-style setting. During the 3 weeks before rash onset, all three cases only participated in activities with others in their respective units.

A second outbreak occurred in 2011 that resulted in 2 generations of spread for a total of 6 cases (3 secondary and 2 tertiary; rash onsets: 2/12/11–3/25/11) in 1 unit. The affected unit housed 900 inmates who lived in double cells. Inmates spent the majority of their time in communal areas and dined together. They had exposure to outside visitors and involvement in educational, recreational, and work activities. It is unknown whether these 6 cases had contact with visitors 3 weeks before rash onset. The index case was in a 42-year old, who worked in the kitchen; the age range of remaining cases was 34–58 years. The index case's exposure source could not be determined. The likely transmission setting for secondary and tertiary cases was the common area shared by the inmates in the unit. No other varicella cases were identified outside of this unit.

Two sporadic cases, one each in 2010 and 2011, occurred in inmates aged 27 and 33 years, who were housed in 2 different units, which were not affected by the 2 outbreaks. The

sporadic cases occurred 7 months and 2 months after the last reported rash onsets of the outbreak-related cases in 2010 and 2011 and were not linked to the outbreak cases. Their source of exposure could not be determined.

No cases of herpes zoster were identified among inmates or staff during the study period. Additionally, no varicella cases were reported in staff after exposure to inmates with varicella, although reporting by staff was voluntary.

VZV seroepidemiology among inmates—In 2010, sera was collected from inmates from 2 units exposed to the outbreak-related cases who did not meet the criteria for evidence of immunity (i.e., were foreign-born or US-born after 1979). Of 260 inmates identified with uncertain immune status, 249 were tested and 248 (99.6%) were VZV IgG seropositive. In 2011, of 407 inmates serologically tested in the affected unit, 395 (97.0%) were VZV IgG seropositive. Among 13 that were not VZV IgG seropositive (9 seronegative and 4 equivocal), the median age of the inmates was 44 years (range, 32–64 years); all but 1 were US-born.

Control Measures for case-patients and exposed inmates—Varicella case-patients were isolated in airborne infection isolation rooms until their lesions crusted over. Cases were isolated for a median of 6 days (range, 6–10 days). Two outbreak-related case-patients in 2011 were temporarily admitted to a local hospital for isolation due to unavailability of airborne infection isolation rooms in the prison.

There were >1,000 inmates exposed. To prevent spread to other units, exposed inmates were confined to their housing units until evidence of immunity could be determined (an average of 2–3 weeks). Ten VZV-seronegative inmates were vaccinated with 2 doses of varicella vaccine >5 days post-exposure; vaccines were provided by the California Department of Corrections and Rehabilitation (CDCR).

Management of Exposed Staff—Following identification of inmate case-patients, steps were taken to notify all staff of the inmate cases, identify exposed staff, investigate their evidence of immunity to varicella, and refer non-immune exposed staff to a contracted occupational health provider for postexposure medical evaluation. Staff were considered exposed if they may have had ≥5 minutes of direct contact with secretions, face-to-face contact, or had been in a small enclosed space with a case-patient. At least 444 staff exposures among staff in the affected units were identified during the 2010 outbreak (some staff may have had multiple exposures). Prison healthcare staff educated staff about the symptoms of varicella, increased risk of severe disease in immunocompromised or pregnant persons, and encouraged staff to notify prison officials if they developed symptoms of varicella.

Exposed healthcare staff were asked to provide evidence of immunity based on guidelines by ACIP (Marin et al., 2007) and the Federal Bureau of Prisons (BOP) (“Federal Bureau of Prisons: Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline,” 2011) in response to the outbreak, which included: 2 doses of varicella vaccine, provider diagnosis of varicella or herpes zoster, or laboratory evidence of immunity or

disease. Non-healthcare workers were asked to self-attest their year and country of birth, and underlying medications and conditions. Based on their responses, a return-to-work coordinator determined the need for referral to an occupational health provider for further evaluation.

II. Varicella outbreak cost assessment

The total estimated costs for management of cases and exposed contacts among inmates in Prison A during the two outbreaks in 2010–2011 was $161,042.88. Estimated costs are shown in Table 2.

There were also additional costs that could not be quantified. To implement measures to control transmission among inmates, staff were diverted from their routine duties to focus on case and outbreak management and control. Additional staff were needed to monitor isolated case-patients and exposed quarantined inmates. This was achieved either by re-deployment of staff from other areas or through overtime. Healthcare staff time and resources were required to implement the screening tool to assess evidence of immunity to varicella (year and country of birth), collect blood for VZV IgG testing, track inmate varicella titers, vaccinate VZV seronegative inmates, evaluate quarantined and isolated inmates on a daily basis, and document results. Because prison health care systems do not have robust patient population registries to track these data, an electronic Access database was developed by healthcare staff to track these data and manage the outbreaks. This database can be used in the future to facilitate control of varicella. Extensive staff time was also spent on conference calls among staff in Prison A, CDCR, and California Department of Public Health (CDPH).

While exposed inmates were confined to their units, they were unable to participate in routine activities, work, and scheduled visits to court. At the height of the 2011 outbreak, Prison A had almost 1,000 inmates on quarantine, many of whom routinely perform critical janitorial, clerical, and food service tasks. Activities that were not classified as critical such as education, manufacturing, religious, visiting, and yard recreation were severely limited during the outbreak, with one unit on quarantine for a month. Operational staff were required to identify and train inmates from non-quarantined areas to continue the core functions of the prison. In addition, quarantine of exposed inmates affected bed moves, transfers into and out of Prison A, and scheduled appointments with visitors.

Discussion

The experience of Prison A demonstrates the challenges and costs associated with controlling and managing varicella in a prison setting. We documented the quantifiable and non-quantifiable costs from disruption of routine activities, medical evaluation, serologic testing, isolation of hundreds of inmates (ill and exposed), and >400 staff exposures, which resulted in >$160,000 spent. The sources of exposure for the two outbreaks, which remain unknown, likely were due to an unrecognized varicella or herpes zoster case in a staff, inmate, or visitor. The high baseline VZV seroprevalence among inmates, which mirrored that of the non-incarcerated U.S. population, likely contributed to limiting disease transmission. Nevertheless, despite high seroprevalence and implementation of control measures, transmission among inmates still occurred. A screening policy for evidence of

varicella immunity for incoming inmates and staff and a vaccination program for those presumed to be susceptible has the potential to mitigate the impact of future outbreaks and reduce resources necessary for managing cases and outbreaks.

Varicella outbreaks have been previously described in prison populations (Getaz et al., 2010; Levy et al., 2003; Prevention., 1989; Valdarchi et al., 2008; Wood & Stevenson, 2004), including several with high VZV seroprevalence (86–99%) (Getaz et al., 2010; Prevention., 1989; Valdarchi et al., 2008), providing evidence that prisons are settings with high risk for exposure and transmission. Although no complications were reported among case-patients in this outbreak, VZV infection can lead to severe disease in populations with higher proportions of immunocompromising conditions, as evidenced by a fatal case of varicella pneumonia previously reported in a HIV-positive inmate (Valdarchi et al., 2008). Our investigation highlights the challenges in controlling disease transmission in this high exposure setting (Baillargeon et al., 2004; Bick, 2007; Breuer, 2004; Restum, 2005). Transmission can occur in the same or another prison unit, and through contact with staff, visitors, and the community through work and activities within the prison, and movement to another facility in the prison system or court (Levy et al., 2003). Effective control measures require timely identification of cases and exposures and implementation of an immediate response when a varicella case is identified, which can be resource-intensive and disruptive for both inmates and staff. Challenges also involve the ability to determine who may have been exposed to varicella and the extent of their contact with the case-patients. Identifying exposed inmates at risk of disease or of severe disease is difficult since information on prior varicella disease, vaccinations, and underlying conditions and medications, are often unavailable, incomplete, or not easily accessible. Furthermore, the ability to isolate case-patients and exposed inmates within prison facilities is often constrained by limited numbers of airborne infection isolation rooms and areas in which to isolate exposed. Occasionally, inmate case-patients who do not clinically require hospitalization are transferred to a local hospital for isolation purposes, which adds additional costs. One cost-benefit analysis found that universal screening and vaccination of varicella-susceptible inmates in the CA state prison population would save $1.3 million and prevent 116 varicella cases in a 5-year period as compared to post-exposure screening and vaccinating inmates (*Mohle-Boetani J. Cost-benefit of varicella prevention in state prisons in California. In: Program and abstracts of the 2011 Academic and Health Policy Conference on Correctional Health (Boston). Worcester, MA: University of Massachusetts Medical School. Available at:* http://www.correctionalhealthconference.com/2011-presentations#seminars). The study compared: 1) the costs that the California Correctional Health Care Services paid for varicella case managment (including the cost of respiratory isolation) and exposure response (e.g., cost of identifying susceptible contacts who needed quarantine) and 2) the predicted costs of screening the entire prison population, providing vaccinations to susceptible inmates, and varicella case management and exposure response assuming a reduction of cases by 60% (the proportion of susceptible inmates expected to accept vaccination). Additional studies to assess the cost-effectiveness of universal screening and vaccination in prison settings would be valuable for guiding the development of varicella disease control recommendations in prison populations.

Infectious disease prevention and control among healthcare and non-healthcare staff in prisons can also be challenging. Accurate identification of exposed staff and those with significant exposures is difficult because staff may be assigned to multiple prison locations as needed. Fortunately, despite the identification of ≥444 staff exposures during the 2010 outbreak, no cases of varicella were reported among staff. However, it is possible that some staff developed varicella, but did not notify prison officials. California Penal Code 6006 *et seq*. authorizes CDCR to evaluate staff for tuberculosis infectiousness and remove staff from work if they do not provide requested certification that they are not contagious ("California Penal Code Section 6006–6009,"). There is no similar provision for varicella infections. Although regulations exist requiring employers to exclude patients with symptoms of aerosol transmissible diseases, there are major challenges in detecting symptoms among staff and administrative challenges in excluding these staff. Similar to the findings of the cost-benefit study among inmates (*Mohle-Boetani J. Cost-benefit of varicella prevention in state prisons in California. In: Program and abstracts of the 2011 Academic and Health Policy Conference on Correctional Health (Boston). Worcester, MA: University of Massachusetts Medical School. Available at:* http://www.correctionalhealthconference.com/2011-presentations#seminars), universal screening and vaccination of susceptible staff would likely be cost-saving if combined with record-keeping to document immune status and policies that target post-exposure medical evaluation towards staff without documented immunity. ACIP has recommended that special considerations for varicella vaccination should be given to those working in environments with high-risk of exposure, including correctional institutions (Marin et al., 2007). Ensuring immunity among healthcare staff ensures protection for staff and reduces post-exposure follow-up. For other staff, a requirement for evidence of immunity to varicella and other vaccine-preventable diseases should also be considered.

An effective method for preventing varicella cases and outbreaks in prison settings is to screen all staff and incoming prisoners for evidence of immunity to varicella, vaccinate susceptible inmates and staff with 2-doses of varicella vaccine on entry, and electronically document this information so that it is readily available in the event of a VZV exposure. Facilities may choose to screen by asking about varicella disease history or by serologic testing. In general, studies have found that self-reported history is a reliable marker of varicella history for adults (Getaz et al., 2010; Perella et al., 2009; Valdarchi et al., 2008), although one study found that the positive predictive value of reported history was low (Wallace et al., 1997). In 2010, two of the cases of varicella occurred among Prison A inmates with self-reported history of varicella.

Birth in the US before 1980 is a criterion for evidence of varicella immunity for the general population [1] based on seroepidemiologic data indicating that >99% of the non-institutionalized US population in that age group has VZV IgG antibodies (Reynolds, Kruszon-Moran, Jumaan, Schmid, & McQuillan, 2010). Three-quarters of the cases in our investigation were US-born before 1980. Although the number of cases in our investigation was small, in a separate analysis of 80 cases of varicella reported from California prisons, 40% were in inmates born in the US before 1980 (California Correctional Health Care Services, unpublished data). These findings raised the question of whether the incarcerated

population might have a different history of exposure to VZV than the general population or whether the crowded conditions in prisons more effectively facilitate transmission. Effective December 2011, the Federal BOP guidelines no longer use birth in the United States before 1980 as evidence of immunity to varicella ("Federal Bureau of Prisons: Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline," 2011).

There were several limitations to our investigation. Costs incurred in 2010 and 2011 were not standardized and data obtained may have been subject to recall bias since they were collected several months after varicella cases occurred. We likely underestimated true costs of outbreak control as we were unable to include several important cost categories: extra-hours spent by prison A staff, CDCR, and the state and local health departments, costs associated with laboratory testing of cases, and costs related to managing exposed staff. In addition, if all testing had been performed at the commercial laboratory, costs would have been higher. Other costs that could not be measured include disruption to the prison system while isolating cases and quarantining exposed inmates, stopping inmate movement, and reorganizing and diverting staff from their routine activities.

We have documented the risk of varicella transmission in prisons and the significant costs and challenges associated with controlling and managing varicella cases and outbreaks in prison settings. Prisons should have clear guidelines for VZV prevention and control to ensure that: 1) appropriate control measures and evaluation of exposed persons are promptly implemented when a single varicella or herpes zoster case is identified ("Centers for Disease Control and Prevention (CDC). Control & Investigation of Varicella Outbreaks," ; "Federal Bureau of Prisons: Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline," 2011); and 2) inmates and staff with varicella, disseminated herpes zoster, or localized herpes zoster among immuncompromised persons are isolated or furloughed from work or activities; those with localized herpes zoster who are immuncompetent may continue to participate in activities and work if they are able to completely cover their lesions ("California Department of Industrial Relations. 5199. Aerosol Transmissible Diseases," ; "Centers for Disease Control and Prevention (CDC). Control & Investigation of Varicella Outbreaks," ; "Federal Bureau of Prisons: Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline," 2011). Although we were unable to conduct a cost-benefit analysis of a universal screening and vaccination strategy through this investigation, one study found this strategy would both prevent cases and reduce costs (*Mohle-Boetani J. Cost-benefit of varicella prevention in state prisons in California. In: Program and abstracts of the 2011 Academic and Health Policy Conference on Correctional Health (Boston). Worcester, MA: University of Massachusetts Medical School. Available at:* http://www.correctionalhealthconference.com/2011-presentations#seminars). Implementation of screening and vaccination of susceptible inmates and staff upon entry or employment, and ready access to this information has the potential to help prevent varicella cases and outbreaks and reduce the costs and challenges related to controlling VZV transmission.

Acknowledgments

Financial Support. There were no sources of financial support.

We would like to thank Lisa Pratt, Allyson Tabor, and Tammy Foss for their assistance in providing information for this manuscript.

References

Baillargeon J, Black SA, Leach CT, Jenson H, Pulvino J, Bradshaw P, Murray O. The infectious disease profile of Texas prison inmates. Prev Med. 2004; 38(5):607–612.10.1016/j.ypmed.2003.11.020 [PubMed: 15066363]

Bick JA. Infection control in jails and prisons. Clin Infect Dis. 2007; 45(8):1047–1055.10.1086/521910 [PubMed: 17879924]

Breuer J. Varicella immunisation for staff and inmates of institutions: is this the next step in the UK? Commun Dis Public Health. 2004; 7(3):162–163. [PubMed: 15481204]

California Department of Corrections and Rehabilitation. Office of Public and Employee Communications. Corrections-Year at a glance. Fall. 2011 Retrieved 24 July 2012, from http://www.cdcr.ca.gov/News/docs/2011_Annual_Report_FINAL.pdf

California Department of Industrial Relations. Aerosol Transmissible Diseases. 5199 Retrieved 17 July 2012, from http://www.dir.ca.gov/title8/5199.html.

California Penal Code Section 6006–6009. Retrieved 01/29/13, from http://www.leginfo.ca.gov/cgi-bin/displaycode?section=pen&group=06001-07000&file=6006-6009

Centers for Disease Control and Prevention (CDC). Control & Investigation of Varicella Outbreaks. Retrieved 20 July 2012, from http://www.cdc.gov/chickenpox/outbreaks/control-investigation.html

de Valliere S, Cani N, Grossenbacher M, Puig F, Masserey E, Bodenmann P. Comparison of two strategies to prevent varicella outbreaks in housing facilities for asylum seekers. Int J Infect Dis. 2011; 15(10):e716–721.10.1016/j.ijid.2011.06.001 [PubMed: 21802330]

Enright F, Mc Mahon B, Washington A. Varicella outbreak in a residential home. Ir Med J. 2006; 99(5):133–135. [PubMed: 16892915]

Faoagali JL, Darcy D. Chickenpox outbreak among the staff of a large, urban adult hospital: costs of monitoring and control. Am J Infect Control. 1995; 23(4):247–250. [PubMed: 7503436]

Federal Bureau of Prisons. Management of Varicella Zoster Virus (VZV) Infections: Clinical Practice Guideline. Dec.2011 2011 Retrieved 10 December 2012, from http://www.bop.gov/news/PDFs/varicella.pdf.

Getaz L, Siegrist CA, Stoll B, Humair JP, Scherrer Y, Franziskakis C, Wolff H. Chickenpox in a Swiss prison: susceptibility, post-exposure vaccination and control measures. Scand J Infect Dis. 2010; 42(11–12):936–940.10.3109/00365548.2010.511259 [PubMed: 20854218]

Glaze, LE. Bureau of Justice Statistics: Correctional Populations in the United States, 2009. Washington, DC: US Department of Justice; 2010. Available at http://bjs.ojp.usdoj.gov/content/pub/pdf/pim09st.pdf Retrieved 27 July 2012

Grossberg R, Harpaz R, Rubtcova E, Loparev V, Seward JF, Schmid DS. Secondary transmission of varicella vaccine virus in a chronic care facility for children. J Pediatr. 2006; 148(6):842–844.10.1016/j.jpeds.2006.01.038 [PubMed: 16769402]

Gustafson TL, Lavely GB, Brawner ER Jr, Hutcheson RH Jr, Wright PF, Schaffner W. An outbreak of airborne nosocomial varicella. Pediatrics. 1982; 70(4):550–556. [PubMed: 6289235]

Leclair JM, Zaia JA, Levin MJ, Congdon RG, Goldmann DA. Airborne transmission of chickenpox in a hospital. N Engl J Med. 1980; 302(8):450–453.10.1056/nejm198002213020807 [PubMed: 7351951]

Leung J, Kudish K, Wang C, Moore L, Gacek P, Radford K, Bialek S. A 2009 varicella outbreak in a Connecticut residential facility for adults with intellectual disability. J Infect Dis. 2010; 202(10):1486–1491.10.1086/656773 [PubMed: 20929354]

Levy MH, Quilty S, Young LC, Hunt W, Matthews R, Robertson PW. Pox in the docks: varicella outbreak in an Australian prison system. Public Health. 2003; 117(6):446–451.10.1016/s0033-3506(03)00138-0 [PubMed: 14522161]

Longfield JN, Winn RE, Gibson RL, Juchau SV, Hoffman PV. Varicella outbreaks in Army recruits from Puerto Rico. Varicella susceptibility in a population from the tropics. Arch Intern Med. 1990; 150(5):970–973. [PubMed: 2158774]

Marin M, Guris D, Chaves SS, Schmid S, Seward JF. Prevention of varicella: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Recomm Rep. 2007; 56(RR-4): 1–40. [PubMed: 17585291]

Mohle-Boetani, J. Program and abstracts of the 2011 Academic and Health Policy Conference on Correctional Health (Boston). Worcester, MA: University of Massachusetts Medical School; Cost-benefit of varicella prevention in state prisons in California. Available at:http://www.correctionalhealthconference.com/2011-presentations#seminars

Noorda J, Hoebe CJ. Fatal outbreak of chickenpox (varicella-zoster virus infection) among institutionalised adults with learning difficulties. Commun Dis Public Health. 2004; 7(3):164–168. [PubMed: 15481205]

Perella D, Fiks AG, Jumaan A, Robinson D, Gargiullo P, Pletcher J, Spain CV. Validity of reported varicella history as a marker for varicella zoster virus immunity among unvaccinated children, adolescents, and young adults in the post-vaccine licensure era. Pediatrics. 2009; 123(5):e820–828.10.1542/peds.2008-3310 [PubMed: 19403475]

Prevention., C. f. D. C. a. Varicella outbreak in a women's prison--Kentucky. MMWR Morb Mortal Wkly Rep. 1989; 38(37):635–636. 641–632. [PubMed: 2505045]

Restum ZG. Public health implications of substandard correctional health care. Am J Public Health. 2005; 95(10):1689–1691.10.2105/ajph.2004.055053 [PubMed: 16186448]

Reynolds MA, Kruszon-Moran D, Jumaan A, Schmid DS, McQuillan GM. Varicella seroprevalence in the U.S.: data from the National Health and Nutrition Examination Survey, 1999–2004. Public Health Rep. 2010; 125(6):860–869. [PubMed: 21121231]

Valdarchi C, Farchi F, Dorrucci M, De Michetti F, Paparella C, Babudieri S, Rezza G. Epidemiological investigation of a varicella outbreak in an Italian prison. Scand J Infect Dis. 2008; 40(11–12):943–945.10.1080/00365540802308449 [PubMed: 18720259]

Wallace MR, Chamberlin CJ, Zerboni L, Sawyer MH, Oldfield EC, Olson PE, Arvin AM. Reliability of a history of previous varicella infection in adults. JAMA. 1997; 278(18):1520–1522. [PubMed: 9363973]

Wood R, Stevenson J. Outbreak of chickenpox in a Scottish prison. Commun Dis Public Health. 2004; 7(3):169–171. [PubMed: 15481206]

Zimmerman L, Fajardo M, Seward J, Ludwig S, Johnson J, Wharton M. Varicella susceptibility and validity of history among U.S. Coast Guard recruits: an outbreak-based study. Mil Med. 2003; 168(5):404–407. [PubMed: 12775178]

Table 1

Characteristics of case-patients in Prison A, California 2010–2011 (N=11)

Characteristic	
Median Age in years (range)	37 (19–58)
US-born; # (%)	11 (100)
US-born before 1980	8 (73)
Median years ever in an adult correctional facility (range)	19 (0–37)
Median years in an adult correctional facility for most recent sentence before rash onset[a] (range)	13 (0–23)
Permanent Inmate; # (%)	8 (73%)
Immunocompromising conditions; # (%)	0 (0)
Outbreak-associated case; # (%)	9 (82)
Documented prior varicella disease history; # (%)	0 (0)
Documented prior varicella vaccination history; # (%)	0 (0)
VZV laboratory confirmed[b] # (%)	5 (45)
Treated with acyclovir; # (%)	2 (18)
Isolated at the Prison A's airborne infection isolation rooms	11 (100)
Isolated at the local hospital	2 (18)

[a] All 6 outbreak-related cases that occurred in 2011 in unit D were among inmates who had been at Prison A for 9–23 years.

[b] VZV viral culture, PCR, or IgM testing.

Table 2

Estimated costs for varicella outbreak control activities in Prison A, California 2010–2011

Cost Category	Estimated Cost
Estimated costs incurred by Prison A	**$156,548.88**
Public health nurse, licensed vocational nurse, and phlebotomist staff time[a]	$23,307.44
Isolation of inmate case-patients in the prison's airborne infection isolation rooms	$18,408.00
Isolation of inmate case-patients in a local hospital[b]	$23,325.44
Laboratory testing of serologic samples from exposed inmates by a commercial laboratory	$1,808.00
Vaccinating 10 seronegative inmates with 2-doses of varicella vaccine[c]	$1,700.00
Lost prison industry production in 2011 due to isolation of inmates (ill and exposed)[d]	$88,000.00
Estimated costs incurred by CA Public Health Department	**$4,494.00**
Laboratory testing of serologic samples from exposed inmates by the public health laboratory	$4,494.00
Total estimated costs incurred by either Prison A or CA Public Health Department	**$161,042.88**

[a] More than full time management by the Chief Medical Officer (CMO), Chief Physician and Surgeon (CP&S), and Public Health Nurse (PHN) were required to manage cases and exposures. CMO and CP&S positions are not eligible for overtime pay.

[b] Cases were isolated at the local hospital because OHU airborne infection isolation rooms were unavailable. Estimated costs included prison staff time to monitor isolated cases in the hospital ($4,900).

[c] The cost of varicella vaccine was $85 per dose; 4 inmates with equivocal VZV IgG results were not vaccinated.

[d] Isolated inmates were unable to work in furniture or mattress manufacturing, which resulted in costs lost by the California Production Industry Authority. Estimated costs not available from the 2010 outbreak.