Ana Paula Moreira Franco-Luiz,
Alexandre Fagundes-Pereira,
Galileu Barbosa Costa,
Pedro Augusto Alves,
Danilo Bretas Oliveira,
Cláudio Antônio Bonjardim,
Paulo César Peregrino Ferreira,
Giliane de Souza Trindade,
Carlos Javier Panei,
Cecilia Mónica Galosi,
**Jônatas Santos Abrahão,**
and Erna Geessien Kroon

Author affiliations: Universidade Federal de Minas Gerais, Belo Horizonte, Brazil (A.P.M. Franco-Luiz, A. Fagundes-Pereira, G.B. Costa, P.A. Alves, D.B. Oliveira, C.A. Bonjardim, P.C.P. Ferreira, G.S. Trindade, J.S. Abrahão, E.G. Kroon); Universidad Nacional de la Plata, Buenos Aires, Argentina (C.J. Panei, C.M. Galosi); Consejo Nacional Investigaciones Científicas y Técnicas, Buenos Aires (C.J. Panei); and Comisión de Investigaciones Científicas Provincia de Buenos Aires,, Buenos Aires (C.M. Galosi)

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Address for correspondence: Erna G. Kroon, Laboratório de Vírus, Departamento de Microbiologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Av. Antônio Carlos, 6627, Caixa Postal 486, CEP 31270-901, Belo Horizonte, Minas Gerais, Brazil; email: ernagkroon@gmail.com
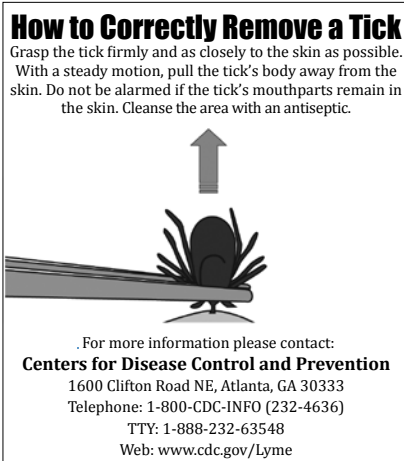
Cerebellitis Associated with Influenza A(H1N1)pdm09, United States, 2013

To the Editor: Central nervous system (CNS) manifestations of influenza are uncommon, especially in adults (*1,2*), and influenza-associated cerebellitis is exceedingly rare: 8 cases have been reported (*3–7*; online Technical Appendix). We describe a case of cerebellitis caused by influenza A(H1N1)pdm09 in an adult woman.

The 37-year-old female patient who sought medical care in Florida, United States, on January 5, 2013, described a 4-day history of intermittent fever of 38.5°C, generalized fatigue, diffuse headache, mild nonproductive cough, 3 episodes of vomiting, and decreased oral intake. On January 4, she experienced acute onset of ataxia and dysarthric speech with slurred pronunciation. She reported no contact with sick persons, recent travel, or exposure to pets or birds. She had a medical history of asthma since childhood, controlled by using montelukast tablets and inhaled steroids. The patient denied having ever received an influenza vaccination.

The patient appeared ill; her oral temperature was elevated at 38.3°C, but other vital signs were within normal limits (blood pressure 109/70 mm Hg; pulse rate 88 beats/minute; respiratory rate 15 breaths per minute; and oxygen saturation 98% at room air). Mucosal membranes appeared normal. No neck stiffness or palpable lymph nodes were noted. Results of heart examination were normal. Lungs were clear to auscultation, and the abdomen was soft, indicating no hepatosplenomegaly or palpable masses. No rash was seen. The neurologic examination revealed normal mental status but moderate ataxic dysarthria. Her cranial nerves were intact, and motor strength was 5/5 throughout. Results of a sensory

examination were normal, and patient's reflexes were largely intact; Babinski sign was absent. However, her coordination was bilaterally impaired in finger-to-nose testing, and her gait was notably broad-based and ataxic.

Laboratory test results showed a leukocyte count of 13.72×10^3 cells/mm³; percentages of neutrophils and lymphocytes were within reference limits at 59% and 25%, respectively. Levels of electrolytes, liver enzymes, and creatine phosphokinase were within reference ranges. C-reactive protein level was below the limit of detection. A nonenhanced brain computed tomographic scan revealed no pertinent findings. Brain magnetic resonance imaging (MRI) revealed enlarged bilateral cerebellar hemispheres with evidence of hypointensity of the affected thoracic vertebral segment on T1 image and hyperintensity on the T2 image (Figure). A lumbar puncture drained clear and colorless cerebrospinal fluid (CSF) with an opening pressure of 15 cm of H_2O. CSF analysis was pertinent, showing presence of erythrocytes (7.5/mm³) and elevated number of leukocytes (330/mm³ [13% neutrophils and 62% lymphocytes]). Glucose and protein levels in CSF were 61 mg/dL and 41 mg/dL, respectively. Blood and urine cultures were

negative for pathogens. A chest radiograph did not show infiltrates. Bacterial culture, acid-fast smear, and culture of CSF were all negative. Blood and CSF tests for HIV syphilis, respectively, were nonreactive. However, reverse transcription PCR (RT-PCR) for influenza A(H1N1)pdm09 virus RNA was positive in the nasopharyngeal swab sample and CSF specimens, at a titer of 4.5×10^5 and 671 RNA copies/mL, respectively. RT-PCR of CSF was negative for viruses, including herpes simplex, Ebstein-Barr, cytomegalovirus, West Nile, and herpes zoster.

The patient was given oseltamivir, 75 mg orally twice daily for 5 days. She experienced a progressive improvement of ataxia and dysarthria during her hospital stay and was discharged after 1 week. At a follow-up visit 2 months later, the patient had remained healthy and neurologically stable.

Cerebellitis, or acute cerebellar ataxia, is an inflammatory process of the cerebellar white matter that occasionally is manifested after systemic viral or bacterial infections (8). The following pathogens are known to cause acute cerebellitis: viruses varicella-zoster, herpes simplex, Epstein-Barr, rotavirus, echovirus, coxsackie, mumps, measles, and rubella; and bacteria *Borrelia burgdorferi*, *Coxiella*

burnetii, *Salmonella typhi*, and *Bordetella pertussis* (8). Although the condition is presumed to be more common in children, adult cases of cerebellitis have been well described (8).

Before this case, influenza cerebellitis had been diagnosed in 8 cases as of 2011 (3–7) (online Technical Appendix Table, http://wwwnc.cdc.gov/EID/article/20/9/14-0160-Techapp1.pdf). Two cases were reported in adult women and the remaining were in children. Four had a probable diagnosis of influenza cerebellitis, although positive viral culture or RT-PCR was lacking (4). Seven case-patients had influenza-like illness preceding the neurologic symptoms (3–6). One case-patient showed evidence of pneumonia, and described the interval from respiratory illness onset to developing of cerebellar signs (6) Clinical sequelae, displayed in most case-patients affected by influenza cerebellitis (3,4,6,7), varied from complete recovery to development of serious complications such as hydrocephalus (5).

The pathogenic mechanism of influenza virus infection on the CNS can be either a direct invasion of the virus that causes acute illness or, more typically, a delayed autoimmune demyelinating postviral encephalopathy (9,10). Amplification of viral DNA in CSF is rare in most influenza-related CNS infections (10). In this case, the positive RT-PCR results for influenza A and the pertinent brain MRI findings, as well as the concurrent influenza prodromal symptoms, suggest that acute influenza cerebelllitis, rather than a postinfluenza encephalopathy, caused the associated neurologic findings.

The limitation of this report includes the lack of sequence data comparing the patient's viral RNA from the CSF and the nasopharynx and the absence of sequential sampling during the course of her illness. In conclusion, influenza virus, though rare, should remain a consideration in patients who have acute cerebellitis during influenza season.
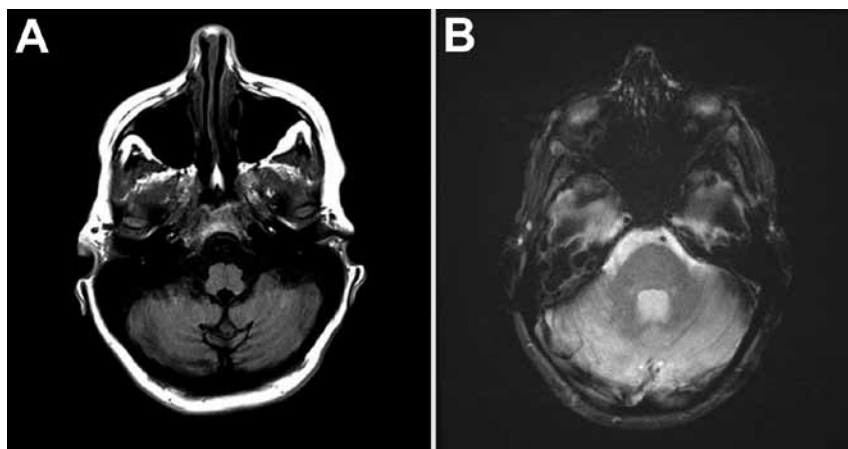
Figure. A) Magnetic resonance images of the brain of a woman with cerebellitis associated with influenza A(H1N1)pdm09, United States, 2013. T1-weighted axial MRI brain sequence showing hypo-intensity of bilateral cerebellar hemispheres. B) T2-weighted axial MRI brain sequence showing hyperintensity of bilateral cerebellar hemispheres.

Maroun M. Sfeir and Catherine E. Najem

Author affiliations: University of Miami Miller School of Medicine/Jackson Memorial Hospital, Miami, Florida, USA (M.F. Sfeir); and Roger Williams Medical Center, Providence, Rhode Island, USA (C.E. Najem)

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Address for correspondence: Maroun M. Sfeir, Department of Medicine, University of Miami Miller School of Medicine/Jackson Memorial Hospital, 1611 NW 12th Ave, Miami, FL 33136, USA; email: msfeir@med.miami.edu

Potential Human Adaptation Mutation of Influenza A(H5N1) Virus, Canada

To the Editor: In December 2013, influenza associated with pandemic influenza A H5N1 was reported in Canada in a patient who had traveled to China; the patient died in January 2014. This case leaves unanswered questions.

In the absence of direct poultry contact by the patient, the possible route of transmission and infection, often influenced by receptor-binding properties of the virus, requires special attention. The full genome and phylogenetic analysis by Pabbaraju et al. (*1*) provides a summary of what can typically be deduced from the sequence. The authors also mention 2 novel mutations, R189K and G221R, in the hemagglutinin (HA) protein (R193K and G225R in H3 numbering, used hereafter). When mapped to the H5 HA protein structure by using FluSurver in GISAID (http://www.gisaid.org, http://flusurver.bii.a-star.edu.sg), both mutations are found in the immediate receptor-binding pocket, and G225R has been known to change specificity of an H3N2 virus toward human erythrocytes (*2*). The same position is also known for receptor recognition changes in the 2009 pandemic H1N1 virus (mutations D222G, D225G, or D239G in different numberings). Besides A/Alberta/01/2014 (clade 2.3.2.1c), the mutation G225R has been found in 3 other H5N1 sequences: A/duck/Hunan/15/2004 (clade 2.3.3), A/chicken/Xinjiang/53/2005, and A/chicken/Xinjiang/27/2006 (both clade 7, all lineage assignments made with LABEL, http://label.phiresearchlab.org/). Although few G225R mutations were found, they were all found in avian hosts, indicating that the mutation can occur sporadically and avian-like receptor-binding properties may not be fully abolished by G225R.

In the absence of glycan-binding data or crystal structures, which take longer to deduce, computational structural modeling is an efficient and safe alternative for fast preliminary assessment of these mutations in their natural structural context of H5N1 binding pockets. We have shown (*3*) that a method using the classical AMBER03 molecular mechanics force field (*4*) with an implicit solvation model in combination with short molecular dynamics simulations in YASARA (*5*) can reproduce relative preference for human-like α2,6-linked versus avian-like α2,3-linked sialic acid receptors. The interaction energies of all atoms in a system are described and combined with distance-dependent functions for different interaction types, including bonds, various angles, van der Waals, electrostatics, and solvent, which leads to consideration of the concerted effects of all residues in the binding pocket. By using this energy function, short molecular dynamics simulations enable all atoms to move for specified intervals within the constraints of their interactions. These simulations are used to minimize and finally predict the energies of the wild-type and mutant HA proteins for their ligand-bound and unbound states considering their respective ligands (see Methods section of [*3*] for details).