Oseltamivir storage, distribution and dispensing following the 2009 H1N1 influenza outbreak in Mexico
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Background
In 2009, Mexico was the first country in the world to declare the outbreak of a novel H1N1 human influenza virus, and San Luis Potosí was one of the Mexican states with the largest number of influenza cases.1–3 The World Health Organization (WHO) and its Regional Office for the Americas, the Pan American Health Organization (PAHO), have pointed out that a strategic stockpile of antivirals needs to be kept on hand and ready for rapid distribution to reduce mortality and serious morbidity.4 To achieve timely access to antiviral medication during an outbreak, best practices in drug procurement, storage, distribution, prescription and dispensing need to be followed.5,6

Mexico developed a national pandemic preparedness plan for influenza in 2006 and created a strategic stockpile of antiviral medication. San Luis Potosí, one of Mexico’s 31 states, is located in the north of the country and has 58 municipalities. It ranks seventh lowest among the 31 states and capital district in deprivation index, its population of about 2.5 million being largely rural and, on average, of low-medium socioeconomic level.1 Antivirals are not generally available locally for use in the public sector primary care services, but access to a national stockpile was recommended as part of pandemic planning.

This study was conducted to describe the structures, policies and processes involved in procuring, storing, distributing and dispensing antivirals during the influenza outbreak that occurred in Mexico before WHO’s declaration of a pandemic, as well as to draw on lessons learnt during the 2009 H1N1 pandemic to inform future pandemic planning and ensure timely access to antiviral medication in future outbreaks.

We conducted an independent, retrospective analysis of the distribution of antiviral medication from the federal stockpile to the state level and within the state of San Luis Potosí, and we assessed the extent to which international and national recommendations were followed. In 2010, approximately 18 months after the influenza outbreak, we interviewed drug stockpile managers of the health ministries in Mexico City and San Luis Potosí and other key informants (15 people in total) to gather information about how the national pandemic preparedness plan for influenza was implemented during the month immediately following the 2009 H1N1 outbreak. We identified several key informants on the basis of their role during the outbreak and obtained from them the names of other key informants through a “snowball” approach. All key informants were individuals who actively helped to implement the national pandemic preparedness plan during the April 2009 influenza outbreak at the federal or state level. The study was approved by the Research Ethics Committee of Mexico’s National Institute of Public Health.

Procurement, storage, distribution and dispensing

Strategic stockpile
In 2006 Mexico’s Ministry of Health decided to create a strategic stockpile of antiviral medication in a central warehouse in Mexico City. The Ministry purchased 1 381 333 treatment courses (i.e. enough for 1.28% of the national population) of oseltamivir from the manufacturer, Roche, and opted for powder in bulk for reconstitution into oral suspension because it was cheaper, had a longer shelf-life (up to 10 years) and occupied less storage space than capsules. Each dose of oseltamivir contains 75 mg and the full treatment course consists of 10 doses (one dose twice daily for 5 days).
A few days after the outbreak of H1N1 was announced on 17 April 2009, Roche, WHO and the governments of France and the United States of America supplemented Mexico’s antiviral stockpile by donating 700,200 treatment courses of oseltamivir (Tamiflu®), which were delivered over the ensuing weeks. In addition, the Ministry of Health purchased 910,000 treatment courses of oseltamivir (Tamiflu®) and 100,000 treatment courses of Relenza® (zanamivir). These donations and purchases consisted of pre-packaged product rather than bulk powder.

**Reconstitution of bulk powder**

Since Mexico’s entire stockpile of oseltamivir was in the form of powder in bulk, the national pandemic preparedness plan provided for using the 31 state-level public health laboratories to reconstitute the powder. However, after the outbreak the Ministry of Health realized that these laboratories were not equipped or authorized to prepare pharmaceuticals. The search for a place where the oseltamivir could be reconstituted delayed stock distribution to the states. Finally, health officials decided to use the central health ministry’s only laboratory, which had a reconstitution capacity of only 5000 treatment courses daily and this further delayed distribution to the states. Additionally, the steps of the reconstitution process were unclear and had to be developed ad hoc, before distribution scale-up. Finally, doubts surrounding the product’s shelf-life arose. Although the commercially available pre-packaged oral suspension of Tamiflu® – i.e. the same product obtained when the powder is reconstituted – has a shelf-life of only 10 days, the oseltamivir reconstituted from bulk during the outbreak was labelled as having a shelf-life of 6 weeks if refrigerated at 4 °C. This confused some health professionals and managers and led them to question the accuracy and trustworthiness of the information provided.

**Distribution of oseltamivir**

It took 11 days after the national outbreak alert and 30 days after the first cases of influenza-like illness were reported in San Luis Potosí for the state’s central warehouse to receive the first batch of oseltamivir suspension from the central laboratory. Over the following three weeks, 16,497 treatment courses (11,817 as capsules and 4900 as oral suspension made from reconstituting oseltamivir phosphate in bulk in the central laboratory), enough for 0.6% of the state’s 2009 population, were recorded in total. Within San Luis Potosi, oseltamivir suspension and capsules were distributed from the central warehouse to the warehouse of each jurisdiction at the state capital and from there to private, social security and public hospitals, or to the only two primary care clinics (of a total of 21 local clinics) that were authorized to dispense oseltamivir.

No prioritization criteria for distribution were specified under the national pandemic preparedness plan (Table 1). An ad hoc decision by the federal Ministry of Health was made to prioritize treatment for patients hospitalized at the National Institute of Respiratory Diseases in Mexico City and prophylaxis for health-care professionals in contact with patient care. Some key informants also indicated that 120 treatment courses of oseltamivir were delivered to each state’s health ministry and that the only available treatment courses were for members of the National Congress, the army and privileged families. It was only after these groups had received a sufficient drug supply that oseltamivir was made available to the population requiring antiviral treatment.

**Prescription and dispensing**

As the national pandemic preparedness plan provided no prescribing or dispensing guidance (Table 1), the health ministry in San Luis Potosí decided to have two public health centres dispense oseltamivir during the first days of the outbreak: one to patients who received prescriptions in the private sector (health ministry dispensing outlet) and the other to patients diagnosed at a state referral centre (AnaHuac Health Centre) for the ambulatory care of patients with influenza-like illness.

During the first weeks of the outbreak the health ministry in San Luis Potosí changed its criteria for oseltamivir treatment to accord with the number of treatment courses available at the state level. At first, only patients with a risk factor for developing complications received prescriptions for oseltamivir, but it was subsequently decided that all patients with influenza-like illness or exposed to the virus should receive a treatment course and post-exposure prophylactic treatment, respectively. Moreover, many health-care professionals received treatment or post-exposure prophylaxis when oseltamivir arrived in San Luis Potosí.

**Evaluation and lessons learnt**

Mexico’s experience is a source of important lessons for other countries, particularly middle-income countries that maintain a strategic stockpile of antiviral drugs (Box 1). First, international organizations have yet to issue specific recommendations with respect to the preferred presentation for oseltamivir stockpiles (whether bulk powder or capsules). Balicer et al. argue that bulk powder has a much longer shelf-life (up to 10 years) and costs much less than either capsules or powder in individual containers for reconstitution by the patient or client. However, the costs of the equipment, suspending agent and human resources needed for reconstitution need to be taken into account when choosing between bulk powder or a pre-packaged product for individual administration. During the 2009 influenza outbreak in Mexico, a strategic stockpile consisting entirely of oseltamivir in bulk for reconstitution delayed stock distribution for more than 10 days. Hence, strategic stockpiles of oseltamivir should preferably consist of a mix of bulk powder, capsules and oral suspension. The addition of other antivirals to the stockpile should also be considered for the treatment of patients with resistance to antivirals or drug allergy.

Second, a portion of the strategic stockpile should be decentralized at the state level for rapid distribution as soon as an outbreak begins. The supply of the drug could be replenished as necessary from a large central depot. In 2007, after a simulation of an influenza outbreak, Mexico’s Ministry of Health recommended decentralizing the strategic stockpile to each state to provide a more rapid response to a possible outbreak. However, the recommendation was never followed or incorporated into the national pandemic preparedness plan for influenza.

Third, there is a need to define quantity and dispensing criteria to improve strategic stockpile management. Mexico’s strategic stockpile (enough to cover 1.28% of the national population) is smaller than the stockpiles of many other upper-middle-income countries,
The Ministry of Health designed stockpiled oseltamivir only as bulk antiviral (oseltamivir phosphate in bulk) was purchased for stockpile. Contrary to the national pandemic preparedness plan, only one antiviral (oseltamivir phosphate in bulk) was purchased for stockpile. Distribution from the central level to the states

Recommended delivery of the bulk product to each state

Contrary to the national pandemic preparedness plan, the strategic stockpile was only centrally stored. An appropriate site for reconstituting the bulk powder had to be found and the reconstitution process had to be developed.

Reconstitution of bulk powder not explained

Priority given to health-care professionals, military personnel, patients hospitalized at the National Reference Centre for Respiratory Diseases and members of the National Congress and Ministry of Health.

Distribution criteria not defined

Compliance with the national pandemic preparedness plan for influenza in Mexico between April and May 2009, according to key informants interviewed

Table 1.

<table>
<thead>
<tr>
<th>Antiviral stockpile supply stage</th>
<th>Information provided or not provided</th>
<th>Compliance/non-compliance during first month of the influenza outbreak</th>
<th>Positive implications of compliance/non-compliance</th>
<th>Negative implications of compliance/non-compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase and storage</td>
<td>No information on the type of preparation to be purchased</td>
<td>Stockpiled oseltamivir only as bulk antiviral (oseltamivir phosphate in bulk) purchased for stockpile.</td>
<td>Compared with capsules, bulk powder is cheaper, requires less storage space and has a longer shelf-life while not reconstituted.</td>
<td>Lack of required infrastructure and financial and human resources during outbreak.</td>
</tr>
<tr>
<td>Distribution within San Luis Potosí</td>
<td>Not described</td>
<td>The Ministry of Health designed the distribution ad hoc during the first 4 weeks of the outbreak. Two outlets at the primary care level dispensed oseltamivir to anyone with a medical prescription.</td>
<td>No need for coordination with the private sector, which was perceived as difficult by key informants.</td>
<td>Complete reliance on the public sector and delays in distribution in this sector affected both private and public sector patients.</td>
</tr>
<tr>
<td>Prescription within San Luis Potosí</td>
<td>Not described</td>
<td>The health ministry in San Luis Potosí designed its own guidelines and adapted them according to the availability of antivirals.</td>
<td>State control over the use of antivirals.</td>
<td>Impossible to cover everyone with influenza-like illness from the start of the outbreak; prescription guidelines changed in conformity with drug availability.</td>
</tr>
<tr>
<td>Dispensing within San Luis Potosí</td>
<td>Not described</td>
<td>The health ministry in San Luis Potosí decided to set up two dispensing outlets at the primary care level for patients with influenza-like illness in the public or private sector.</td>
<td>State control over the dispensing of antivirals.</td>
<td>Supply bottlenecks in the public sector affected both private and public sector patients.</td>
</tr>
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</table>

including Brazil (5%), Romania (7%), Thailand (7%) and Algeria (25%). If Mexico should decide to cover 25% of its population with antivirals, as some high-income countries have done, it would have to invest 12.9% of its annual health expenditure, in sharp contrast to the 0.11% invested by developed countries. If it should decide to cover everybody likely to fall ill during an outbreak, it would have to cover at least 12% of the population and spend 6.2% of its total health budget. Otherwise, criteria should be defined a priori for priority coverage of specific population groups, and the general population should be informed of this. For instance, PAHO recommends that antivirals be
given prophylactically to health-care professionals, firefighters, police officers and people in age groups at risk, such as children and the elderly, independent of other priority groups that a country might establish.7

Finally, Mexico’s national pandemic preparedness plan needs to be updated to incorporate the important lessons learnt from oseltamivir distribution and dispensing during the 2009 influenza outbreak. The plan has not been updated since 2006.

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Competing interests: None declared.

Box 1. Summary of main lessons learnt

- Strategic stockpiles of antiviral medication for pandemic influenza should consist of a mix of bulk powder, capsules and suspension of oseltamivir plus other antivirals to cover patients with antiviral resistance or drug allergies.
- A portion of the strategic stockpile should be kept decentralized for more rapid distribution immediately after an influenza outbreak.
- There is a need to define quantity and dispensing criteria a priori to facilitate strategic stockpile management during an influenza outbreak.

Summary of main lessons learnt

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stratégique. Un stock d'oseltamivir en poudre était centralisé pour une distribution à l'ensemble des 31 états et à la capitale en cas d'épidémie de grippe.

**Environnement local** San Luis Potosí, dans le nord du Mexique, figurait parmi les états les plus durement touchés par l'épidémie de grippe H1N1 de 2009.

**Changements significatifs** L'oseltamivir en poudre était supposé être reconstitué localement, mais il a toutefois dû être de manière centralisée lors de l'épidémie de grippe de 2009. Des doutes ont commencé à se poser quant à la durée de conservation du produit reconstitué. Suite à ces difficultés, San Luis Potosí n'a reçu sa première livraison du médicament que 11 jours après le début de l'épidémie de grippe. En outre, les critères de cet état en termes d'administration ont dû être modifiés selon la disponibilité de l'oseltamivir.

**Leçons tirées** Les prévisions relatives à la demande de médicaments antiviraux devraient se baser sur des critères de distribution et d'administration clairement définis. Il faut également envisager la décentralisation de certaines réserves de médicaments. Le plan national mexicain de préparation aux pandémies doit être révisé en fonction des leçons apprises en 2009 afin d'améliorer la gestion stratégique des stocks et de permettre la livraison d'oseltamivir à la population dans les meilleurs délais.

### References


Lessons from the field

Antiviral stockpile management in Mexico’s 2009 influenza outbreak

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