Original Article

Evaluation of the severe acute respiratory syndrome (SARS) surveillance system, with emphasis on influenza, Brazil, 2014-2016*

doi: 10.5123/S1679-49742020000300013

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Abstract

Objective: to evaluate attributes of the severe acute respiratory syndrome (SARS) surveillance system in Brazil, 2014-2016. **Method:** this was an evaluation study conducted according to United States Centers for Disease Control and Prevention guidelines. Data from the Influenza Web information system notified for the period 2014-2016 were used. The simplicity, completeness, inconsistency, timeliness, acceptability, representativeness, positive predictive value (PPV) of the SARS case definition attributes and usefulness were evaluated. **Results:** a simple structure was found with good completeness (100% for required variables; >95% for optional variables); low inconsistency (3.2%); lack of timeliness (68.2%); low acceptability (average of 70.4%); representative of the territory (capable of analyzing risk groups); high PPV (29.1%); useful (fulfils system objectives). **Conclusion:** the attributes evaluated indicate that the system is capable of providing complete, representative and useful information about influenza, adequate for guiding national health responses.

Keywords: Severe Acute Respiratory Syndrome; Evaluation Study; Program Evaluation; Epidemiologic Surveillance Services.

*This article was derived from the Master's Degree dissertation entitled "Evaluation of the severe acute respiratory syndrome (SARS) surveillance system, with emphasis on influenza, Brazil, 2014-2016", defended by Igor Gonçalves Ribeiro at the University of Brasília (UnB) Faculty of Health Sciences Public Health Postgraduate Program in 2019.

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Introduction

Influenza is a viral infection of the upper and lower respiratory tracts. It is caused by RNA viruses of the Orthomixoviridae family, subdivided into types A, B and C. Type A virus is the most mutagenic and important regarding human infection, and its predominant subtypes in Brazil are A(H1N1)pdm09 and A(H3N2).[1,2]

Its main reservoirs are human beings, mammals and birds.[2,3] Susceptibility is general and transmission occurs through contact with respiratory secretions or droplets, principally in the coldest period of the year (autumn and winter), and in the South and Southeast regions of Brazil. Incubation in humans lasts for one to four days, while transmissibility occurs between 24 hours after the onset of symptoms until the fifth day. The main signs and symptoms are: fever, cough, sore throat, shivering, malaise, headache, myalgia, arthralgia, prostration, rhinorrea, chest pain, diarrhea, vomiting, fatigue, hoarseness, conjunctival hyperemia and, in more severe cases, dyspnea (shortness of breath).[4-7]

> *Universal surveillance of SARS also requires collection and analysis of nasopharyngeal secretion or post mortem material of all hospitalized SARS cases for identification of the infecting virus.*

The main factors and risk groups associated with infection and clinical complications are: pregnancy, puerperium, immunosuppression, closed or partly closed environments (e.g. houses, schools and kindergartens), age <5 years or ≥ 60 years, indigenous village dwellers and people with chronic diseases.[7-11]

Measures to prevent influenza infection include respiratory isolation of infected people, use of personal protective equipment by health professionals, vaccination of priority risk groups and timely treatment with medication (within 48 hours from onset of symptoms).[7-10]

Over 120 years, from 1889 to 2009, Brazil faced six substantial influenza epidemics, which contributed to the structuring and enhancement of the national epidemiological surveillance system.[1,12-15] One of these structured components is universal surveillance of severe acute respiratory syndrome (SARS), which began in 2009, following the World Health Organization (WHO) declaration of a Public Health Emergency of International Concern in view of human cases of influenza A(H1N1) pdm09. The new system aimed to identify the profile of influenza pandemic cases and deaths based on the clinical picture of SARS, this being its most serious manifestation. In order to record the corresponding epidemiological data on notified caes, the Influenza Web component of the Notifiable Health Conditions Information System (SINAN) was also established in 2009.[4,14]

Universal surveillance of SARS also requires collection and analysis of nasopharyngeal secretion or post mortem material of all hospitalized SARS cases for identification of the infecting virus. The main diagnosis methods used are real-time polymerase chain reaction (RT-PCR) and the indirect immunofluorescence (IIF) method.[1-3]

Since its implementation, the system has undergone several adjustments to variables and changes in case definition, but had never been submitted to a process of evaluation of the quality of its attributes and its usefulness.[1,16,17]

As such, the objective of this study was to evaluate the attributes of the severe acute respiratory syndrome (SARS) surveillance system for the period 2014-2016.

Methods

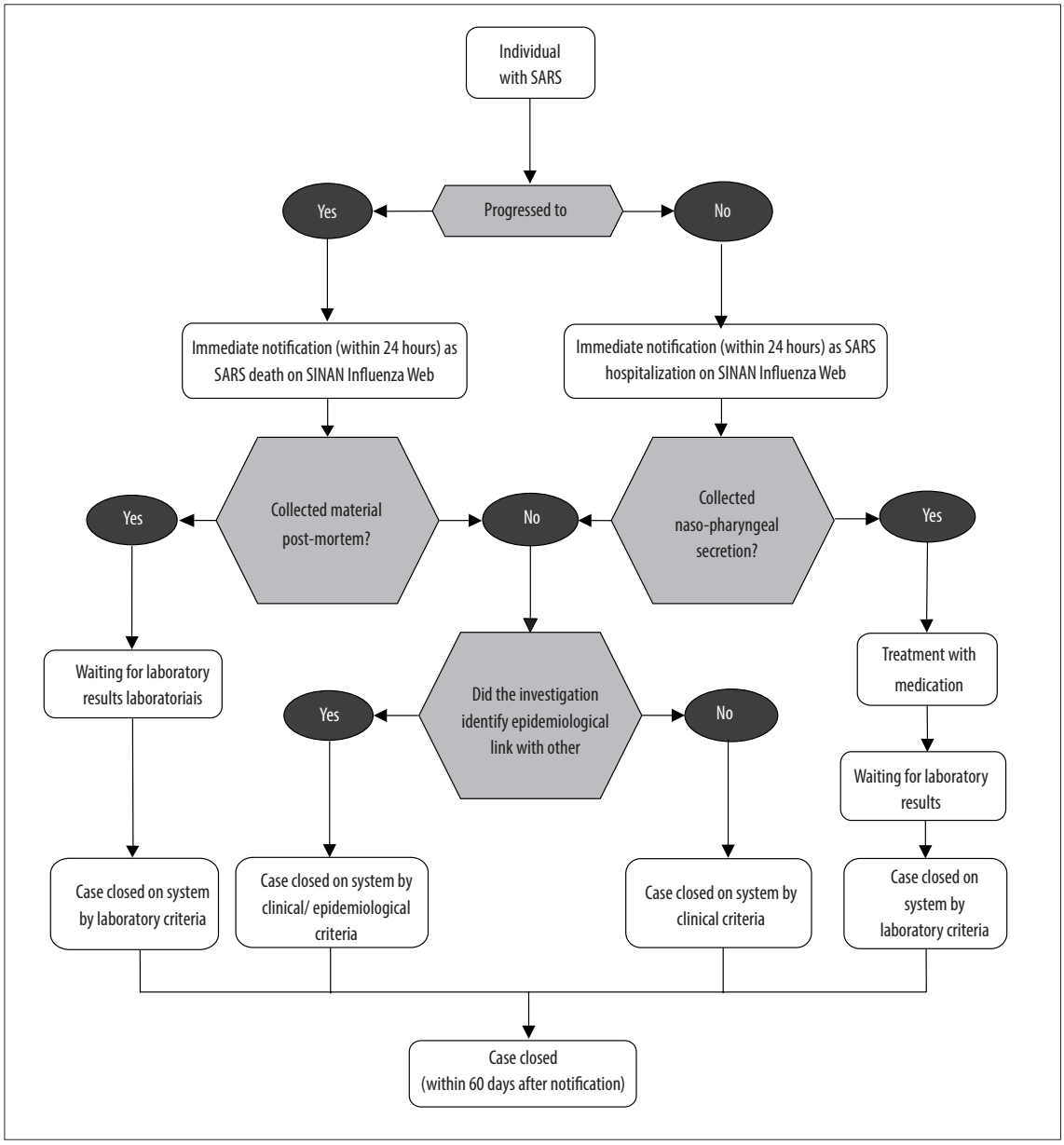
An evaluation study of the SINAN Influenza Web information system was performed, based on the United States Centers for Disease Control and Prevention (CDC) Updated guidelines for evaluating public health surveillance systems: recommendations from the guidelines working group,[18] which recommends analysis of the pertinent quantitative and qualitative attributes of surveillance systems, based on references and evaluation criteria (scores) for each attribute. In this study the simplicity, completeness, inconsistency, timeliness, acceptability, representativeness, positive predictive value (PPV) attributes and system usefulness were evaluated.

We studied those individuals who had manifested SARS symptoms in Brazil and who had been notified on the notifiable health conditions information system (SINAN Influenza Web), taking Brazil to be the place of study, given that SARS has been a compulsorily notifiable health condition throughout the national territory since 2011.[12] We analyzed cases with onset of symptoms between January 1st 2014 and December 31st 2016.

In order to describe the system, we analyzed specific components of protocols pertinent to surveillance structure. In order to evaluate the system's attributes, we used the SINAN Influenza Web database required and key variables for time period mentioned above. We also consulted health professionals external to SARS surveillance with experience in health system evaluation studies, for them to review the references and the evaluation scores used in the study.

System description

Once hospitalized, a case may or may not die within a space of 24 hours. In the event of death, samples



Source: Ministry of Health, 2019[3]; Ministry of Health, 2015[4]; Ministry of Health, 2016[17].

Figure 1 – Notification and investigation flowchart for severe acute respiratory syndrome (SARS), Brazil, 2014-2016

are collected post mortem, and the notification form is closed according to the laboratory criterion based on the sample results. If samples are not collected post mortem, the case is investigated according to clinical and epidemiological confirmation criteria (Figure 1).[3,4,17]

In the event of notification of a hospitalized SARS case, nasopharyngeal laboratory samples are collected. If sample collection is not possible, the clinical and epidemiological data of contacts are investigated for confirmation and closure of the notification form (Figure 1).[3,4,17]

The SINAN Influenza Web information system has a notification form with required and optional variable fields, referring to socio-economic, prior history and clinical health aspects, laboratory results and final case classification following investigation. The form is filled in online and the data are uploaded immediately to the national database following notificati on form closure.[3,4,17]

References and attribute analysis criteria

Simplicity

The references used for evaluation of the simplicity attribute were the descriptions of SARS case management flowchart, notification and investigation used nationally.

As evaluation criteria a SARS surveillance system should have:

1. A well-defined drawn case care flowchart with adequately described interconnections;
2. Few institutional levels involved in case notification and confirmation, i.e. one case notification/investigation institution and one laboratory analysis referral institution;
3. Small quantity of laboratory tests to be performed and analyzed for case confirmation/dismissal (maximum of two confirmatory tests).

A system is considered to be simple if it meets the evaluation criteria described above.[18]

Completeness

The reference here was percentage completeness of five required key variables:

1. Case identification unit (present or not on the notification form);
2. Symptom onset date (present or not on the notification form);
3. Date of birth (present or not on the notification form);
4. Sex (male/female/unknown);
5. Date of closure (present or not on the notification form).

And six optional variables:

1. Vaccination against flu (yes/no);
2. Use of antiviral medication (yes/no);
3. Progressed to hospitalization (yes/no);
4. Chest x-ray taken (yes/no);
5. Use of mechanical ventilation (yes/no);
6. Sample collected (yes/no).

The required variables were chosen because if they are not filled in on the form the system does not allow the form to be closed, and also because they provide information that is important for social and demographic characterization of cases. The optional variables were chosen because they provide an all-round view of care delivered to SARS patients.

With regard to the evaluation criterion for the required variables, 100% filling-in of the fields in the period analyzed was considered to be satisfactory. In the case of the optional variables, filling-in of fields greater than 70% was considered to be satisfactory, this being the minimum percentage capable of enabling adequate description of the variable.[19]

Inconsistency

The reference for inconsistency was derived from the analysis of the percentage of samples collected before the onset of symptoms (sample collection date earlier than symptom onset date). With regard to the evaluation criterion, if the percentage was equal to or less than 20%, data inconsistency was considered acceptable.[18]

Timeliness

The following topics were used as timeliness references:

Healthcare timeliness: the difference in days between SARS symptom onset date and hospitalization date. Healthcare provision was considered to be timely when it occurred within one day of symptom onset;

Notification timeliness: the difference in days between hospitalization date and notification date. Notifications done within one day of hospitalization were considered to be timely;

Treatment timeliness: the difference in days between hospitalization date and date on which treatment with medication began for those who had treatment. Treatment started within two days of hospitalization date was considered to be timely;

Sample collection timeliness: the difference in days between hospitalization date and sample collection date, if samples were taken. Samples collected within seven days of hospitalization were considered to be timely;

Investigation closure timeliness: the difference in days between notification date and investigation closure date on the form, if investigation had effectively been closed. Investigation closure within 60 days at the most after notification date was considered to be timely.

Each reference had a timeliness percentage. As to the evaluation criterion, system timeliness was considered to be satisfactory if the simple average of the percentages for the entire period was equal to or greater than 70%.[18]

Acceptability

Information system acceptability was evaluated indirectly based on the notification timeliness and sample collection timeliness attributes. With regard to the evaluation criterion, if the simple average for timeliness was equal to or greater than 80%, then system acceptability was considered to be satisfactory.[18]

Representativeness

Representativeness was analyzed by the ability of the surveillance system to identify, in the given study period, SARS cases due to respiratory viruses in circulation in Brazil, the country's regions (Federative Unit of residence variable) and age ranges (categorical variables: 0-4 years, 5-9 years, 10-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years and ≥60 years) most affected by SARS. With regard to the evaluation criterion, if the surveillance system was capable of describing SARS behavior in Brazil, then it was considered to be representative.[18]

PPV

The following references were used to evaluate the PPV of the SARS case definition on the system for detection of viral infections.

1. Individuals with investigation concluded ("date of closure" variable filled in) which met the SARS case definition according to the signs and symptoms recorded:

a) "fever = yes" variable;
b) followed by "cough = yes" or "sore throat = yes";
c) followed by "headache = yes", or "myalgia = yes", or "arthralgia = yes";
d) followed by "dyspnea = yes" or "O_2 saturation <95% = yes".

2. Individuals with confirmed respiratory virus infection confirmed on the System:

a) Individuals who met the SARS case definition according to signs and symptoms, together with
b) "etiological diagnosis" variable = 1- positive";
c) followed by "influenza A = positive", or "influenza B = positive", or "other respiratory viruses = positive".

*As such, the proportion of individuals with confirm*ed viral infection in relation to those who only met the SARS case definition was considered to be the PPV of the surveillance system case definition. Given that according to the literature, between 20% and 30% of notified SARS cases relate to viral infections,[1,17] if the value found in this study was greater than 20%, then PPV was considered to be satisfactory.[18]

Usefulness

The reference used for usefulness of the universal SARS surveillance system was its ability to fulfill its objectives as stipulated by the national protocol.[20] The objectives of the universal SARS surveillance system in Brazil are: to monitor respiratory viruses in circulation in the country; to accompany morbidity and mortality trends associated with the disease; to identify risk groups associated with the disease; to detect and provide a rapid response to new subtype circulation; and to produce and disseminate epidemiological information.

With regard to the evaluation criterion, if the surveillance system objectives were fulfilled, then the surveillance system was considered to be useful.[18]

The data were analyzed based on measurements of absolute frequency, relative frequency, central tendency and dispersion. Epi Info™ 7.2.3.1 and Microsoft Office Excel® 2016 were used for data processing.

It should be noted that fields filled in as "unknown" were considered to be filled-in fields, and only missing values were considered to be unfilled fields.

Results

We analyzed 89,954 SARS records with onset of symptoms between January 1st 2014 and December 31st 2016.

Analysis of the simplicity attribute showed that the universal SARS surveillance system has: a drawn healthcare/notification flowchart described in official documents, describing notification as SARS, its progress, tests

performed and respective results, and final case classification (Figure 1); one notifying/investigating institution, which is the sentinel unit providing care to the case, and one local referral laboratory, which is Central Public Health Laboratory (LACEN) in the same territory as the sentinel unit; and two different diagnosis methods in the surveillance service for case confirmation, namely RT-PCR and IIF.

As the SARS surveillance system achieved the evaluation scores for this attribute, it was classified as being simple.

With regard to the completeness attribute, in relation to the required variables, the filling in of the "onset of symptoms", "sex" and "date of closure" variables was considered to be satisfactory. On the other hand, the "case identification unit" and the "date of birth"

Table 1 – Evaluation of completeness, inconsistency and timeliness of the severe acute respiratory syndrome (SARS) epidemiological surveillance system, Brazil, 2014-2016

Required variables	2014 (N=19,289)		2015 (N=14,936)		2016 (N=55,729)		Total (N=89,954)	
	N	%	N	%	N	%	N	%
Case unit	19,268	99.9	14,934	99.9	55,722	99.9	89,924	99.9
Symptoms	19,289	100.0	14,936	100.0	55,729	100.0	89,954	100.0
Birth	19,254	99.8	14,914	99.8	55,557	99.7	89,725	99.7
Sex	19,289	100.0	14,936	100.0	55,729	100.0	89,954	100.0
Closure date	19,289	100.0	14,936	100.0	55,729	100.0	89,954	100.0
Optional variables								
Vaccination	18,809	97.5	14,626	97.9	54,507	97.8	87,942	97.8
Antiviral	18,881	97.9	14,530	97.3	54,871	98.5	88,282	98.1
Hospitalization	19,189	99.5	14,806	99.1	55,473	99.5	89,468	99.5
X-ray	18,401	95.4	14,233	95.3	53,500	96.0	86,134	95.7
Ventilation	18,738	97.1	14,503	97.1	54,468	97.7	87,709	97.5
Sampling	19,159	99.3	14,745	98.7	55,284	99.2	89,188	99.1
Inconsistency	**2014 (N=17,290)**		**2015 (N=13,522)**		**2016 (N=50,042)**		**Total (N=80,854)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Collection before symptoms	574	3.3	462	3.4	1,551	3.1	2,587	3.2
Timeliness	**2014 (N= 19,289)**		**2015 (N=14,936)**		**2016 (N=55,729)**		**Total (N=89,954)**	
	Timely	**%**	**Timely**	**%**	**Timely**	**%**	**Timely**	**%**
Healthcare	6,327	32.8	4,993	33.4	18,001	32.3	29,321	32.6
Notification	10,997	57.0	8,123	54.4	34,461	61.8	53,581	59.6
	2014 (N= 11,212)		2015 (N=6,898)		2016 (N=39,665)		Total (N=57,775)	
	Timely	%	Timely	%	Timely	%	Timely	%
Treatment	9,361	83.5	5,625	81.5	33,494	84.4	48,480	83.9
	2014 (N=17,160)		2015 (N=13,331)		2016 (N=49,597)		Total (N=80,088)	
	Timely	%	Timely	%	Timely	%	Timely	%
Collection	13,429	78.2	10,614	79.6	41,048	82.8	65,091	81.3
	2014 (N=17,909)		2015 (N=13,864)		2016 (N=51,632)		Total (N=83,405)	
	Timely	%	Timely	%	Timely	%	Timely	%
Case closure	16,708	93.3	12,411	89.5	40,709	78.8	69,828	83.7

variables were not 100% complete. In relation to the optional variables, all of them were satisfactory as completeness was above 95.0% (Table 1).

It was therefore found that 9 out of the 11 variables studied (81.8%) had satisfactory completeness for the criteria stipulated. The SARS surveillance system was therefore classified as having satisfactory completeness.

With regard to the inconsistency attribute, data inconsistency was around 3.2% for the total of 80,854 records with confirmed sample collection. Inconsistency as per the analysis was therefore considered to be acceptable (Table 1).

In relation to the timeliness attribute, timeliness of healthcare and notification were evaluated for a total of 89,954 records, and the result was 32.6% timely healthcare provision and 59.6% timely notifications. Treatment timeliness was evaluated for 57,775 records of cases that effectively had antiviral treatment, 83.9% of which were timely. With regard to laboratory sample collection timeliness, of the total 80,088 records of cases with material collected for laboratory tests, 81.3% were timely. And in relation to timely closure, out of the total of 83,405 cases closed in the period analyzed, 83.7% of records were timely (Table 1).

The simple average of the timeliness items evaluated for the entire period resulted in 68.2% overall timeliness. As such, according to the evaluation criteria used, the universal SARS surveillance system was considered to be untimely.

In the case of indirect evaluation of the acceptability attribute based on timeliness analyses, in the period studied notification timeliness was 59.6% and laboratory sample collection timelines was 81,3% (Table 1), whereby the simple average was 70.4%, thus classifying SARS surveillance acceptability for health professionals as being unsatisfactory.

In relation to the representativeness attribute, SARS cases were notified throughout Brazil over the period analyzed (2014-2016), with a higher level of notifications in 2016, mainly for influenza. Case recording also increased in the coldest periods of the year in Brazil, namely from March to August (Figure 2). This study found the states forming the Southern region of Brazil, together with the states of São Paulo, Rio de Janeiro and Minas Gerais were those that most notified SARS cases (Table 2).

Children under five years old and adults aged 60 or over formed the age groups most affected by SARS in Brazil. Higher frequency of influenza can be seen in those over 60 years old, while higher frequency of other respiratory viruses can be seen in children under five years old. It can also be seen that in 71.0% (63,901/89,954) of notified cases, the SARS etiologic agent was not identified (Table 3).

As the SARS surveillance system is capable of describing SARS behavior in Brazil in terms of time, place and person, and duly highlights the age groups most affected (under five-year-olds and over sixty-year-olds) as well as the main Federative Units in which cases were recorded (South and Southeast regions), it was considered to be representative.

Regarding analysis of case definition PPV, out of a total of 64,214 records showing investigation to be concluded and which met the SARS case definition, 18,714 records had positive laboratory results for respiratory viruses, resulting in 29.1% PPV. According to the evaluation criteria, this PPV value was satisfactory.

With regard to usefulness, the SARS surveillance system was capable of fulfilling its function of monitoring respiratory viruses, and was also capable of identifying them according to laboratory criteria as well as by clinical/epidemiological criteria. The system was also capable of demonstrating syndrome distribution and trend over the years studied (Figure 2) e (Table 2).

Moreover, the system identified age groups at greater risk of SARS, specifically identifying influenza or other respiratory viruses in relation to these groups, thus also confirming the adequacy of the IIF and RT-PCR methods for identifying new viral subtypes (Table 3).

As such, SARS surveillance was capable of achieving the recommended objectives for respiratory virus monitoring, describing the epidemiological situation, identifying trends and specifying risk groups, so that the system was classified as useful.

Discussion

The universal SARS surveillance system was evaluated as having a simple flowchart, good data completeness, low inconsistency, being untimely for clinical management and notification, having low acceptability for health professionals, being representative of the territory, having satisfactory PPV for respiratory viruses, and being useful for epidemiological analyses.

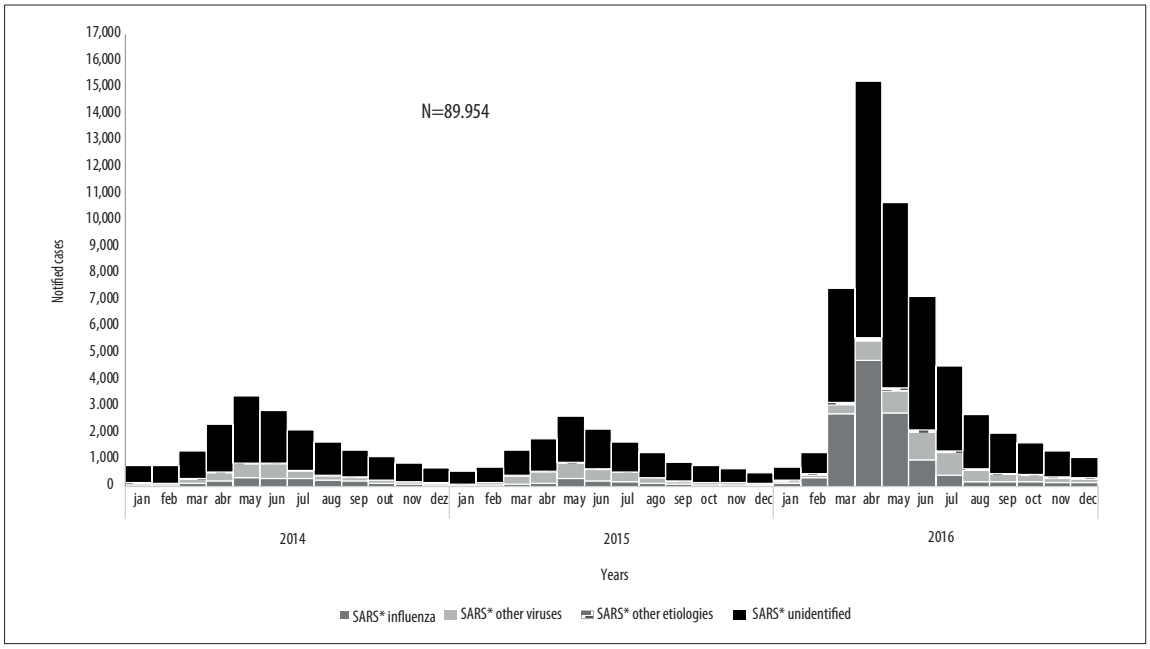


Figure 2 – Distribution of notified severe acute respiratory syndrome (SARS) cases, by month and etiologic classification, Brazil, 2014-2016

Table 2 – Distribution of notified severe acute respiratory syndrome (SARS) cases by region and Federative Unit, Brazil, 2014-2016

Region/Federative Unit	2014	2015	2016	Total
North	**591**	**335**	**1,648**	**2,574**
Rondônia	85	54	198	337
Acre	153	118	384	655
Amazonas	1	4	26	31
Roraima	38	9	30	77
Pará	182	93	775	1,050
Amapá	88	42	154	284
Tocantins	44	15	81	140
Northeast	**2,208**	**1,872**	**4,470**	**8,550**
Maranhão	77	34	69	180
Piauí	82	28	185	295
Ceará	178	296	536	1,010
Rio Grande do Norte	209	166	352	727
Paraíba	25	12	288	325
Pernambuco	1,151	1,044	1,613	3,808
Alagoas	19	2	134	155
Sergipe	0	4	122	126
Bahia	467	286	1,171	1,924

to be continued

continuation

Region/Federative Unit	2014	2015	2016	Total
Southeast	**8,919**	**5,760**	**29,753**	**44,432**
Minas Gerais	2,778	1,370	5,097	9,245
Espírito Santo	87	75	978	1,140
Rio de Janeiro	659	532	2,543	3,734
São Paulo	5,395	3,783	21,135	30,313
South	**6,147**	**5,493**	**15,109**	**26,749**
Paraná	2,868	2,455	6,696	12,019
Santa Catarina	1,333	726	2,787	4,846
Rio Grande do Sul	1,946	2,312	5,626	9,884
Midwest	**1,359**	**849**	**4,034**	**6,242**
Mato Grosso do Sul	577	286	1,702	2,565
Mato Grosso	243	97	571	911
Goiás	387	364	1,192	1,943
Distrito Federal	152	102	569	823
Unknown/blank	**65**	**627**	**715**	**1,407**
Total	**19,289**	**14,936**	**55,729**	**89,954**

Table 3 – Distribution of notified severe acute respiratory syndrome (SARS) cases, by age group and etiologic classification, Brazil, 2014-2016

Age group (years)	SARS Influenza		SARS Other viruses		SARS Other etiologies		SARS Unidentified		Total	
	N	%	N	%	N	%	N	%	N	%
0-4	3,002	19.5	7,745	78.8	315	38.5	25,917	40.6	36,979	41.1
5-9	758	4.9	285	2.9	18	2.2	2,803	4.4	3,864	4.3
10-19	820	5.3	218	2.2	65	7.9	3,140	4.9	4,243	4.7
20-29	1,331	8.6	222	2.3	78	9.5	4,383	6.9	6,014	6.7
30-39	1,884	12.2	211	2.1	86	10.5	5,118	8.0	7,299	8.1
40-49	2,017	13.1	202	2.0	69	8.4	4,798	7.5	7,086	7.9
50-59	2,409	15.6	230	2.3	67	8.2	5,489	8.6	8,195	9.1
≥60	3,183	20.7	717	7.3	121	14.8	12,253	19.2	16,274	18.1
Total	**15,404**	**100.0**	**9,830**	**100.0**	**819**	**100.0**	**63,901**	**100.0**	**89,954**	**100.0**

Simple epidemiological surveillance systems are preferable because they are accepted better by health professionals and because of their low cost, despite having problems in terms of incorporating new technologies.[18] This difficulty of new technology incorporation was not found in the system studied. To a great extent this was due to the system being handled digitally.[3,18]

The good completeness and low inconsistency found enabled surveillance to be able to count on good epidemiological analyses, capturing cases from all over Brazil and providing reliable information.[21,22]

Systems available via internet also facilitate incorporation of new variables at low cost. As SARS is capable of presenting new nuances owing to etiologic agent diversity, the suggestion is made that the system should be capable of adapting to new case definitions as they emerge, so that the system denotes potential.[4,18]

The untimeliness of the system, affected by healthcare provision and case notification timeliness, may have been influenced in four ways: (i) patient delay in seeking treatment; (ii) delay in access to hospital inpatient services; (iii) lack of health professional training in relation to SARS cases; and (iv) presence of chronic comorbidities as a clinical confounding factor.[23-27] With regard to chronic comorbidities, clinical confusion has been increasingly reported in specialized literature, leading health professionals to place preference on treating the chronic disease to the detriment of treating the communicable disease.[26,28,29]

This study examined acceptability as a reflection of service timeliness; it is therefore not only based on the evaluation of the health professionals involved, but also relates to health institution management and organization to improve the delivery of this type of healthcare.[18,26,29]

Immediate notification of suspected cases on the information system contributed to its representativeness, increasing the range of cases captured throughout the national territory. However, problems relating to low case recording in some states may not be related to surveillance itself, but rather to the current health system, such as lack of access to healthcare services. Other factors contributing to good representativeness were good completeness and low inconsistency, which make the data evaluated more reliable and correct.[1,5,14,21]

Satisfactory PPV for cases identified as having respiratory viruses is reflected in the fact of universal SARS surveillance being based on identification of clinical pictures that may be caused by diverse respiratory etiologic agents: viruses, bacteria, chronic diseases, among others. Detecting these viruses is therefore one of the elements for identifying agents that cause SARS, increasing surveillance system power to identify specific cases through laboratory detection or by clinical/epidemiological criteria. On the other hand, the magnitude of SARS cases caused by other etiologic agents remains unknown because of failure to expand the laboratory test panel.[18,22,24,27]

A limitation of this study relates to the subjective references for measuring the attributes which may contribute to possible information bias, namely confirmation bias. We sought to minimize this effect by inviting professionals external to surveillance to take part in validating the references and evaluation criteria.

Finally, we conclude that the SARS surveillance system is useful, as it is highly capable of capturing cases owing to its case definition, as well as enabling good representativeness of cases identified among the Brazilian population. Furthermore, the data have good analytical quality due to the low level of incorrect or missing data.[14,18]

We therefore recommend that federal managers of the system ensure: training of clinical personnel in SARS diagnosis, adequate case management (respiratory isolation and treatment of severe cases) and timely provision of treatment; training of state and municipal personnel in immediate SARS investigation including sample collection; advising health professionals as to the importance of treating SARS with medication, principally cases suspected of having influenza (greater severity); and ensuring more timely delivery of laboratory analysis results to epidemiological surveillance services.

Authors' contributions

Ribeiro IG and Sanchez MN designed the study, analyzed and interpreted the data and drafted the first version of the manuscript. Ribeiro IG and Sanchez MN interpreted the data and critically reviewed the manuscript. The authors have approved the final version and are responsible for all aspects thereof, including the guarantee of its accuracy and integrity.

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Received on 30/03/2020
Approved on 13/05/2020

Associate Editor: Lucia Rolim Santana de Freitas - orcid.org/0000-0003-0080-2858