Dengue in Nicaragua

A review of control status, trends, and needs

February 2011

PATH

This document is part of a larger case study on Nicaragua's health system and diagnostic needs. The health system case study employed two main methodological approaches. The first was a review of official Ministry of Health (MINSA) data and epidemiological reports, as well as publications in peer-reviewed journals. The second was a concurrent series of field visits in 2008 to provide firsthand evidence of diagnostic needs and difficulties. A more detailed account of these methodological approaches can be found in the methodology section of the health system case study.

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About PATH

PATH is an international nonprofit organization that creates sustainable, culturally relevant solutions, enabling communities worldwide to break longstanding cycles of poor health. By collaborating with diverse public- and private-sector partners, PATH helps provide appropriate health technologies and vital strategies that change the way people think and act. PATH's work improves global health and well-being.

Cover photo: PATH/Tala de los Santos

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Glossary

CNDR	Centro Nacional de Diagnóstico y Referencia (National Diagnostic and Reference Center)
COMBI	Communication for behavioral impact (a strategy for the modification of community conduct)
MINSA	Ministerio de Salud (Ministry of Health)
PAHO	Pan American Health Organization, a regional office of the World Health Organization
PATH	Program for Appropriate Technology in Health
RAAN	Región Autónoma del Atlántico Norte (North Atlantic Autonomous Region)
RAAS	Región Autónoma del Atlántico Sur (South Atlantic Autonomous Region)
SILAIS	Sistemas Locales de Atención Integral de Salud (Local Comprehensive Health Care Systems, which are the Nicaraguan health system's 17 administrative units corresponding to the country's departments and autonomous regions)
VTD	Vector Transmitted Disease
WHO	World Health Organization

Overview

Dengue displays an endemoepidemic behavior in Nicaragua and has an epidemiological, social, and economic impact. All four dengue serotypes circulate in the country, and the vector is widely distributed with high infestation rates.

A total of 23,035 cases were recorded in Nicaragua between 1985 and 1989. This number nearly doubled to 61,302 between 1990 and 1997 and then increased by a further 58% to 106,635 cases up to 2007. This represents an accumulated total of 190,972 recorded cases of dengue in Nicaragua in 23 years (Figure 1).[1]

The recent situation

The first significant dengue outbreak in Nicaragua occurred in 1985, affecting most of the country's departments, or states. A total of 17,483 suspected cases were reported (Figure 2), along with seven deaths from hemorrhagic dengue. Surveillance efforts resulted in the isolation of eight strains of the Den-1 and Den-2 serotypes suspected to be responsible for the outbreaks. The following year 484 cases and one death were reported (Figure 1).[2]

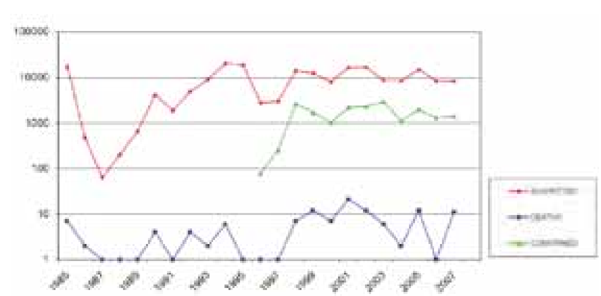
The Den-3 serotype was detected for the first time in Central America in 1994. Its circulation in Nicaragua coincided with an outbreak in 1994 and 1995 involving approximately 39,000 suspected cases (20,469 in 1994 and 19,268 in 1995). While the whole country was affected, the majority of cases occurred in the departments of Managua and León.

The following two years saw significantly fewer cases, but 26,506 suspected and 4,309 confirmed cases were reported in 1998 and 1999 when isolates of Den-4 were detected in addition to Den-2 and Den-3. This included an important outbreak in the administrative health units (SILAIS) of Masaya, where nine people died, while the SILAIS of Managua and León were also seriously affected. During this first period (1985–2007) only 20% to 40% of reported cases were actually investigated.[3]

In 2002, a national outbreak attributed to the circulation of the Den-4 and Den-1 serotypes affected the SILAIS in Río San Juan, Matagalpa, and Nueva Segovia, the latter of which was the site of an important Den-1 outbreak. The national outbreak resulted in 16,723 suspected cases and 2,310 confirmed cases. Twelve deaths were recorded, all from complications related to hemorrhagic dengue fever or dengue shock syndrome.

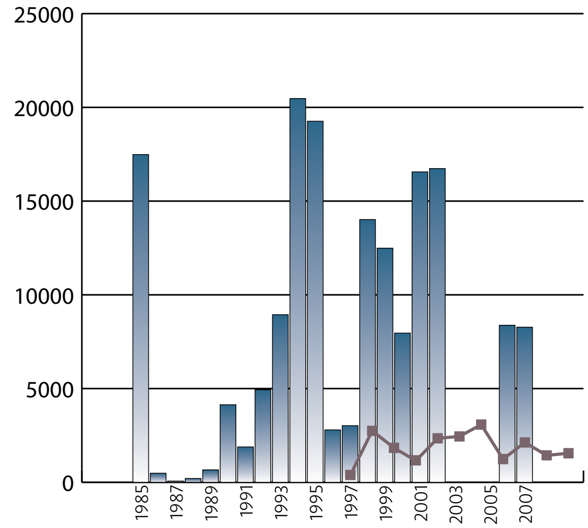
The last major outbreak was in 2005 with 14,749 suspected cases and 1,991 confirmed cases, compared to 8,422 suspected cases and 1,097 confirmed cases in 2004. This represented a 43% increase in cases and an 83% rise in mortality compared to the annual average for 2003 and 2004. The outbreak affected the whole country, although the highest incidences were recorded in the Managua, Masaya, and North Atlantic Autonomous Region (RAAN) SILAIS. The circulating serotypes were Den-1, Den-2, and Den-4.[4]

FIGURE 1: **Suspected cases and deaths from dengue, Nicaragua 1985–2008**



Source: National Dengue Program

FIGURE 2: **Suspected and confirmed cases of dengue in Nicaragua**



The current situation

In 2007, around 8,500 suspected cases of dengue were reported, including 1,415 laboratory-confirmed cases of classic dengue (16% of suspected cases) (Figure 2) and 150 confirmed cases of hemorrhagic dengue. Eleven deaths were reported. The incidence rate was 2.53 per 10,000 inhabitants, and the mortality rate was 2.11 per 100,000 inhabitants.[5]

From January to May of 2008, a total of 127 cases of classic dengue and 11 cases of hemorrhagic dengue were confirmed, for an incidence rate of 0.22 per 10,000 inhabitants.[6]

Seasonality

Although there are cases all year, the highest amount for both classic dengue and hemorrhagic dengue occur during the rainy season, which begins in May and lasts until November or December (Figures 3 and 4). September and October are the wettest months.

FIGURE 3: **Confirmed cases of classic dengue fever per week, 2005–2007**

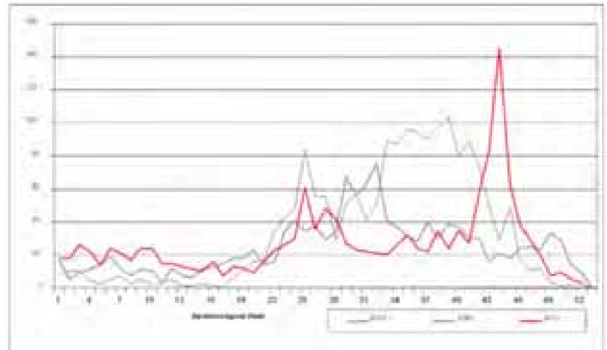
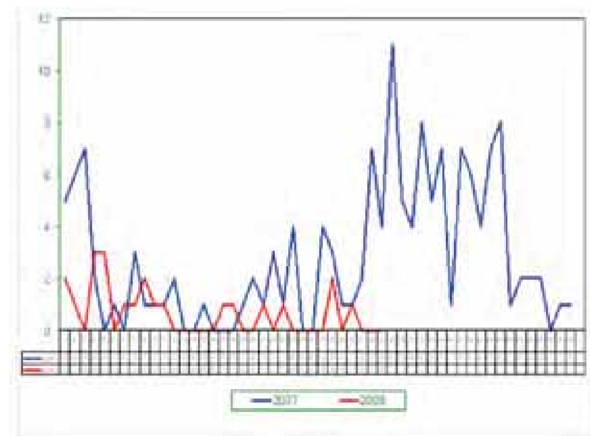


FIGURE 4: **Dengue hemorrhagic fever: Confirmed cases per week, 2007–2008**



Dengue types

All four types of the dengue virus have been found in Nicaragua and cause intense outbreaks when they first appeared. Den-1 and Den-2 were first detected in 1985, Den-3 in 1994, and Den-4 in 1996. Den-1 and Den-4 are blamed for the outbreak of 2002.

The main groups affected

Morbidity is highest among 5- to 14-year-olds (incidence rate of 3.5 per 10,000 inhabitants), followed by children under 1 (2 per 10,000) and 15- to 49-year-olds (Figure 5).

The 5- to 14-year-olds and 15- to 49-year-olds have the largest numbers of hemorrhagic dengue cases, but the highest rates (confirmed cases/total age-group population) are found among those under 1 and 5- to 14-year-olds, where the mortality rates are 0.6 and 0.3 per 100,000 inhabitants, respectively (Figure 6).[7]

Women are most affected, representing 728 (55%) of the 1,415 cases in 2007. This is because the vector is found in houses, making women more susceptible given their house-bound roles, and because women use skirts, thus leaving a greater area of the body uncovered, facilitating mosquito bites on their legs.

FIGURE 5: **Rates of classic dengue by age group. Nicaragua, 2006–2007**

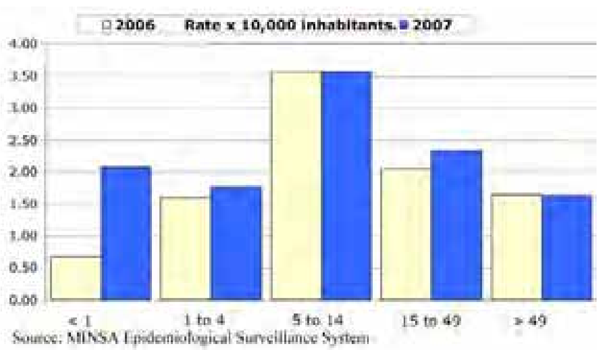
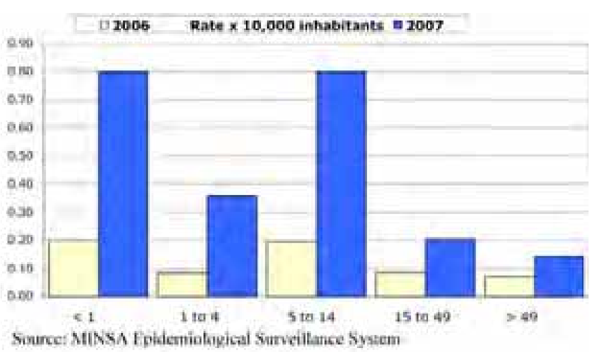


FIGURE 6: **Rates of dengue hemorrhagic fever by age group. Nicaragua, 2006–2007**



Symptoms of dengue

The findings of a 2007 study of children diagnosed with dengue admitted to the La Mascota Children's Hospital in Managua revealed the clinical symptoms of classic dengue to include fever, headache, retro-orbicular pain, and general malaise that may also include rash, petechia, hemorrhagic manifestations, and positive tourniquet test. Petechiae are more common (73%) in type 1 dengue fever symptoms, while ecchymosis, epistaxis (nosebleeds), gingivorrhagia, edema of the gall bladder wall, ascites, and pleural effusion are commonly seen in type 2 dengue fever.[8]

Vectors

Aedes aegypti (the yellow fever mosquito) is the primary vector for transmission of dengue in Nicaragua and is present in all of the country's main urban centers, as it only breeds in clean water. In 2007 the country had a house infestation index of 6.7%, with 70% of SILAIS registering an infestation index of 5% or greater,[9] which is considered high risk according to the Nicaraguan guidelines (Figure 7).

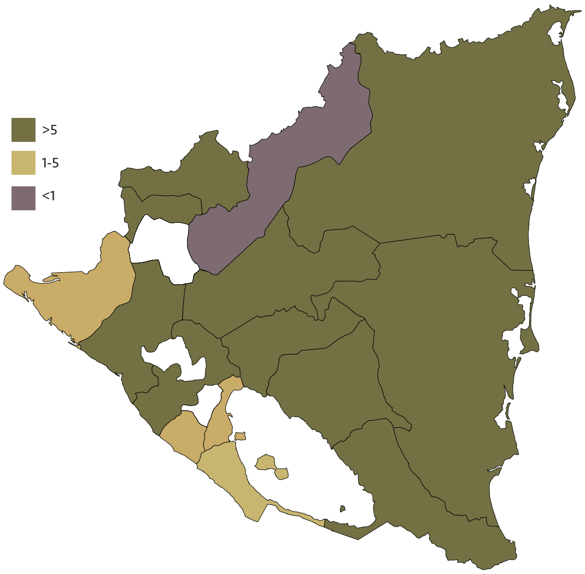
High rates of Aedes aegypti infestation persist in the country's main cities, partly because of the irregular supply of potable water. The local populations employ water collection and storage methods that provide breeding places for the mosquito. Habits and behaviors that favor infestation by Aedes aegypti in Nicaragua include the accumulation in backyards of receptacles and other junk that can retain standing water, a reluctance to use larvicides, and the premature cleaning of larvicide residue. The mosquito's distribution has also increased in recent years due to the "pseudo-urbanization" of rural settlements, particularly along the country's main highways.

Aedes albopictus, which unlike Aedes aegypti is more associated with rural areas, also has been detected in some parts of the country (e.g., the Subtiava neighborhood of the city of León, Ocotal in the department of Nueva Segovia, Potosí in the department of Chinandega, and Los Chiles in the department of Río San Juan). However, this insect has not been identified as a current carrier of dengue in Nicaragua.

Hemorrhagic dengue

The fact that the four dengue serotypes have circulated in Nicaragua increases the probability of epidemics of hemorrhagic dengue. This is because infection by one serotype of the dengue virus confers immunity only against that specific serotype while at the same time increasing the possibility of hemorrhagic dengue if infected by any of the other three.

FIGURE 7 : **Infestation of houses by *Aedes aegypti* in 2007 in Nicaragua**



Certain serotypes, such as Den-2, are more virulent. The simultaneous transmission of several serotypes also increases the risk of hemorrhagic dengue. There is currently a higher potential risk of dengue hemorrhagic fever (DHF) due to the circulation of the Den-3 serotype and the simultaneous circulation of multiple serotypes (Den-1, Den-2, Den-3, and Den-4). The Den-3 serotype last circulated in 1999, and more than 1,351,000 people are estimated to be susceptible to it.[10]

Factors that influence dengue

Circumstances that heighten the threat of dengue epidemics include:[11]

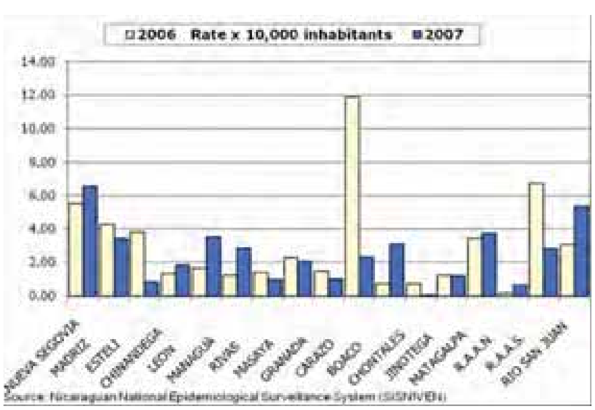
- Increasing urban population trends. Fifty-six% of the population is concentrated in the increasingly urban Pacific coast region, and 40% of the total urban population lives in Managua.
- The existence of bedroom towns around the capital city.
- Uncontrolled, unplanned urbanization and inadequate environmental management.
- Poverty and illiteracy. Forty-eight% of the population lives in poverty, and 19% of those older than ten years are illiterate.
- The absence of basic utilities, such as electricity, drinking water, sanitary sewerage systems, and garbage collection services.
- Overcrowding and limited water supplies. Thirty-seven percent of houses are overcrowded, 29% of schools have no water supply.

Geographic distribution

Although the locations of the different outbreaks have varied over the years—depending on factors such as viral circulation, favorable environmental conditions, and the effectiveness of the immediate control measures—the Pacific coast region is considered to be at greatest risk due to its higher levels of urbanization and the population's prior exposure to various types of dengue. However, other areas such as Nueva Segovia, the North and South Atlantic Autonomous Regions (RAAN and RAAS), and Matagalpa have become increasingly important in terms of dengue epidemics, which are closely linked to water supply problems in those areas.

In 2007, 74% of cases in Nicaragua corresponded to six SILAIS— Chinandega, León, Managua, Masaya, Matagalpa, and Nueva Segovia—that have also registered the highest number of cases in previous years (Figure 8, Appendix 1).[12] The incidence rates in León, Madriz, Managua, Nueva Segovia, the RAAS, and Río San Juan are all higher than the national average, while the SILAIS on the Pacific side of the country—particularly Managua and León—plus Nueva Segovia have reported the most cases of hemorrhagic dengue and death from dengue (Appendix 1).

FIGURE 8: **Rates of classic dengue by SILAIS. Nicaragua, 2006–2007**



Outbreaks

The following is a summary of three recent outbreaks:

Managua, 2002: The outbreak was located mainly in the areas covered by four health centers: Villa Libertad, Edgard Lang, Francisco Buitrago, and Pedro Altamirano. It involved 684 confirmed cases and an attack rate of 5 per 10,000 inhabitants. Factors that favored the outbreak included an Aedes aegypti household infestation index of over 25%; the simultaneous circulation of the Den-1 and Den-2 serotypes; increased numbers of household mosquito breeding sites (6% presence of potential breeding sites in the houses); and the reluctance of 17% of the population to use the Abate larvicide. Forty percent of people willing to use the larvicide threw it away seven days after its application.[13]

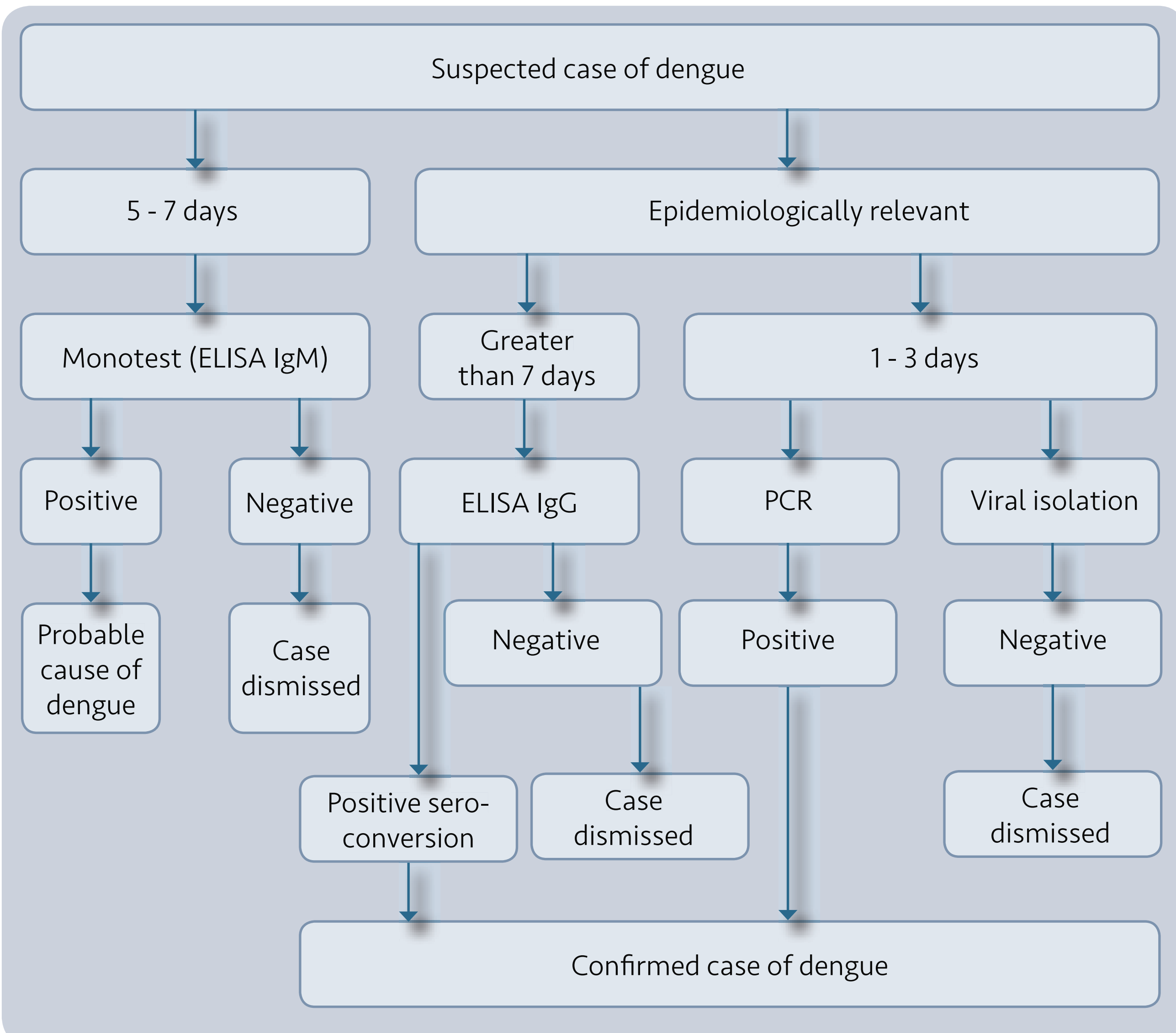
Chontales, 2003: The outbreak occurred in the cities of Juigalpa and San Pedro de Lóvago. It involved 76 confirmed cases with an attack rate of 1.9 x 10,000 inhabitants. The outbreak was influenced by water supply problems (65% household coverage), a lack of sanitary sewerage systems, garbage collection problems (70% coverage), and a 5.7% infestation index.[14]

Carazo, 2006–2007: An outbreak of cases of Den-3 in the last quarter of 2006 appears to have originated with Nicaraguan students returning from El Salvador and spread as a result of high Aedes aegypti infestation indices. The outbreak involved 141 cases and one death. Another outbreak occurred at the beginning of 2007, focused on the areas of La Paz, San Marcos, Diriamba, Jinotepe, and El Rosario. Risk factors in this zone include irregular water supply (water coverage of 70% in urban areas); inappropriate water storage methods; an increase in the infestation indices in semirural areas; commuting to Managua and neighboring cities, which can help spread the disease; the lack of systematic control actions, such as the application of the Abate larvicide; and a lack of vector control human resources in the countryside. Control actions included the use of support brigades from neighboring departments for intensive Abate application in all of the cities, ultra low-volume fumigation using portable equipment and a LECO pesticide sprayer, an education campaign, clean-up days, and organization of the health services.[15]

Government control strategies

Diagnosis

FIGURE 9: **Algorithm for dengue diagnosis**



As well as being fundamental for epidemiological surveillance and the timely implementation of control actions, laboratory diagnosis is essential for the therapeutic monitoring of patients. This is particularly true for serious cases during outbreaks of leptospirosis, meningococcemia, influenza, and dengue where early diagnosis and suitable treatment can save lives.

Serological diagnosis

The mono test (ELISA IgM detection)

The mono test is the routine Ministry of Health (MINSA) test to diagnose dengue. It is currently available at the National Diagnostic and Reference Center (CNDR) in Managua and seven SILAIS laboratories (Bluefields, Chinandega, Chontales, Estelí, Granada, León, and Matagalpa). The reagents are locally produced in the CNDR. Each test costs US$1.

Health workers take the samples in the health unit—where the patient is treated for between five and seven days after the symptoms first appear[16]—and then send them to the corresponding regional or central laboratory. In the health unit, the sample must be centrifuged or the serum manually separated before being sent to the laboratory, which may cause problems in some cases. The health workers make no special trips to deliver these samples and instead wait to take advantage of other trips, which leads to delays in receiving the results. Similarly, samples sent from more isolated places can be lost or can deteriorate during transportation (mainly through hemolysis).[17]

Between 8,000 and 10,000 serological samples are tested for dengue in Nicaragua every year, representing around 95% to 98% of the total cases. In 2007, 1,415 (12%) of the 8,753 samples tested positive. The CNDR also carries out quality control on 10% of the negative samples and all of the positive samples in the country.[18]

The main limitation of the test is that it cannot be used in the first days following the appearance of dengue symptoms. The patient therefore has to come back five days later, during which time contact with the patient could be lost. It takes between ten and 25 days to receive results in those municipalities that do not have the capacity to test the samples.[19]

Paired sera analysis (ELISA IgG /total antibody detection)

Available only at the CNDR, this test is conducted in special circumstances to identify primary and secondary cases of dengue, as well as cases of epidemiological interest that were identified late. It requires a second convalescence sample after 14 days.[20]

Serological response:

- Primary case: Total antibody titration by ELISA inhibition < 2,560.
- Secondary case: Total antibody titration ≥ 2,560.

The identification of primary and secondary cases is useful in identifying the evolution and magnitude of a focus and evaluating the control actions and is important for completing the epidemiological investigation.

Virological methods

Viral isolation

Available only at the CNDR, this method tests samples taken within three days of the initiation of dengue symptoms. It identifies the dengue serotype involved, helping to monitor viral circulation and gauge the severity of the outbreak.

RT-PCR

Real-time PCR tests are currently available only at the CNDR. They test samples taken within five days of the appearance of symptoms, when antibody levels are still not detectable and there is a need for a rapid diagnosis, such as in serious cases.[21]

The annual number of tests performed in shown in Appendix 2.

Differential diagnosis

Currently all samples tested for dengue are also automatically analyzed for leptospirosis, regardless of the results, using a single epidemiological form. If the results are negative for both illnesses and the patient's case is followed up, however, the attending doctor makes the final diagnosis according to clinical presumption.[22] In 2006, 8,275 samples were tested as a result of epidemiological surveillance throughout the country, of which 1,350 (16%) were positive for dengue, 55 (0.66%) were positive for leptospirosis, and 6,870 (83%) were negative for both.[23]

Pediatric patients with fever are automatically tested for measles and rubella. Both disease are still under surveillance and control in Nicaragua's immunization program, though the country has had no measles case since 1995 and no rubella cases since 2006. According to the respective diagnosis algorithms, any suspected case of measles or rubella that tests negative is also tested for dengue, which is considered a differential diagnosis given that dengue can also cause fever and a rash similar to measles and rubella.

Control strategies

In 2004, Nicaragua created a national integrated dengue strategy with a behavior-based, multi-sector, comprehensive, and interdisciplinary approach that integrates the following components: social promotion and communication, epidemiological surveillance, laboratory procedure, vector control, patient health care, and environmental sanitation.[24]

Social promotion and communication

COMBI strategy

Nicaragua has been gradually applying a communication for behavioral impact (COMBI) strategy for the modification of community conduct. The strategy is based on plans and programming and is implemented with and for the community. This new strategy was first implemented in two communities covered by the Silvia Ferrufino Health Center in the Managua SILAIS for 18 months with funding from the Pan American Health Organization (PAHO). It was subsequently implemented in the Chontales, Jinotega, León, Madriz, Masaya, and Nueva Segovia SILAIS.[25]

Another strategy for modifying community conduct is a basic dengue booklet that provides elementary school teachers with essential information on the disease to pass on to their students. The idea is to change the habits of students and their families to ensure ongoing control of the Aedes aegypti mosquito. For the last three years, the Education Ministry has introduced the booklet into elementary schools in the urban areas of nine Nicaraguan departments, and it is currently pending implementation in the Caribbean coast region (RAAN and RAAS). The booklet was translated into Creole English, Mayangna, and Miskito in collaboration with the University of the Autonomous Regions of the Caribbean Coast of Nicaragua to facilitate its dissemination to Caribbean coast pupils in the languages spoken in their communities.[26]

SEPA approach

Nongovernmental organizations have also implemented other interventions and approaches to modify community behaviors to combat dengue. Evidence-based, community-derived interventions for prevention and control of dengue in Nicaragua, conducted from 2004 to 2007, use the socializing evidence for participatory action (SEPA) approach, implemented by CIET International in collaboration with the University of California at Berkeley. The heart of this approach is an informed dialogue with community members based on their own evidence, including questionnaires; entomological surveys that identify Aedes larvae and pupae in participants' households; and serological evidence of dengue infection in children, obtained by analyzing the change in dengue virus-specific antibody levels in the children's saliva.

During the first year of interventions, in 2004, a panel of 30 sentinel sites (130 houses each, for a total of 3,956 households) was selected to represent the population of Managua. In the first year, entomological surveys detected a house index of 8% to 44% in the 30 sites, while serological results indicated that 8% to 44% of children had been bitten by a dengue-infected mosquito. Entomological, serological, and interview data are used to measure the impact of an intervention and also feed back to the community through house visits and focus groups to catalyze and direct an informed intervention. The interventions consist of a communication strategy based on local knowledge and experience, led by community leaders and dengue health volunteers. The second cycle, in October 2005, measured the impact of the first year's interventions and refined them with community input. By Year 3, the hope was to determine whether the communities were likely to carry on the process independently.

Sanitation

This strategy is based on achieving a political commitment between the municipalities and the central government through multisectoral working groups to implement complementary actions to reduce environmental risk factors.[27]

Laboratory procedures

The decentralization of the ELISA IgM mono test to seven SILAIS laboratories and the local production of the reagents have helped improve laboratory diagnosis in Nicaragua, with the aim of producing timely, high-quality diagnosis and information.[28]

Vector control

Key elements in the vector control strategy include:

Environmental sanitation campaigns: These involve clean-up and sanitation activities stressing the elimination in local houses of potential breeding grounds for Aedes aegypti (including household items that can collect water and be used as breeding places by the mosquitoes). Organized in urban and semiurban areas of each municipality, the campaigns involve the local government and population. Four anti-epidemic campaigns took place in 2008, emphasizing the community's role in dengue prevention.[29]

Larvicide campaigns ("Abatization"): Six to eight national campaigns are carried out each year involving house-to-house visits by technical personnel or health volunteers to inspect houses and their surroundings for potential breeding grounds (old tires, barrels, water channels, etc.). Any potential breeding areas are destroyed and the temephos larvicide (temephos 1% at 20g per 200 liters of water) is applied. The inhabitants are also counseled on how to prevent the illness. In 2007, staff and volunteers made 2,936,309 visits to houses,[30] for a coverage of 76% of the programmed houses.[31]

These activities are evaluated through entomological surveys that track house infestation indices. In 2007, a total of 14,481 of the 217,267 houses included in the survey resulted positive, for an infestation index of 6.7% and a Breteau index (number of containers with immature stages per 100 houses inspected) of 7.9%.[32]

Fumigation: Zones identified by entomological or epidemiological indicators as high risk are fumigated to control the larvae and mosquito population, break the chain of transmission, and control outbreaks. The insecticide used for Aedes aegypti control in Nicaragua is cypermetrine (25%). This is applied outdoors using a LECO machine with ultra low-volume dispersal, which is most effective during the coolest hours of the day and at night. Although indoor household fumigation with portable fumigation machines has proved effective in interrupting epidemic outbreaks, a fumigation team can only cover 80 houses a day, so much more equipment and personnel would be needed to cover more extensive areas.[33] In 2007, a total of 738,398 houses were fumigated with motor-backpack fumigation equipment and nearly 200,000 acres sprayed by LECO machine.[34]

Epidemic focus control in response to suspected cases: Activities to control epidemic focuses are essential within at least 500 meters of suspected or identified dengue cases. These include the search for new cases, epidemiological investigation, house inspections, destruction of breeding sites, the application of larvicide, open-air fumigation using cypermetrine, and sanitary education.[35]

Anti-epidemic health campaigns: Five campaigns are conducted every year to promote community participation in the different prevention and control activities, including clean up, destruction of breeding sites, application of larvicide, and education.[36]

Patient health care

Although there is no specific treatment and there are no vaccines for dengue, the ministry of health has case management guidelines to stabilize patients and prevent dengue shock syndrome. National Dengue Healthcare and Prevention Guidelines (Appendices 3 and 4) have been produced and are currently being reviewed,[37] with the aim of achieving the more timely identification, diagnosis, and treatment of dengue patients.

Surveillance system

Dengue is a disease under epidemiological surveillance (Figure 10) for which immediate notification is compulsory, with information recorded on notification forms by sex and age group and on an epidemiological case sheet. The epidemiological surveillance system is based around the community or local health post. Health post staff report the case to the municipal level, where the information is consolidated before being sent on to the SILAIS level and from there to the central level (Figure 11).

The cases are classified as follows:

Suspected dengue: All febrile cases accompanied by headache, retroorbital pain, myalgia, arthralgia, vomiting, abdominal pain, rash and/or hemorrhaging.[38]

Suspected hemorrhagic dengue: All suspected cases with hemorrhaging accompanied by one or both of the following: thrombocytopenia (low platelet count of <100,000) or signs of plasma extravasation (increase in hematocryte of 20%, pleural discharge, ascites, and hypoproteinemia).

FIGURE 10: **National epidemiological surveillance system in Nicaragua**

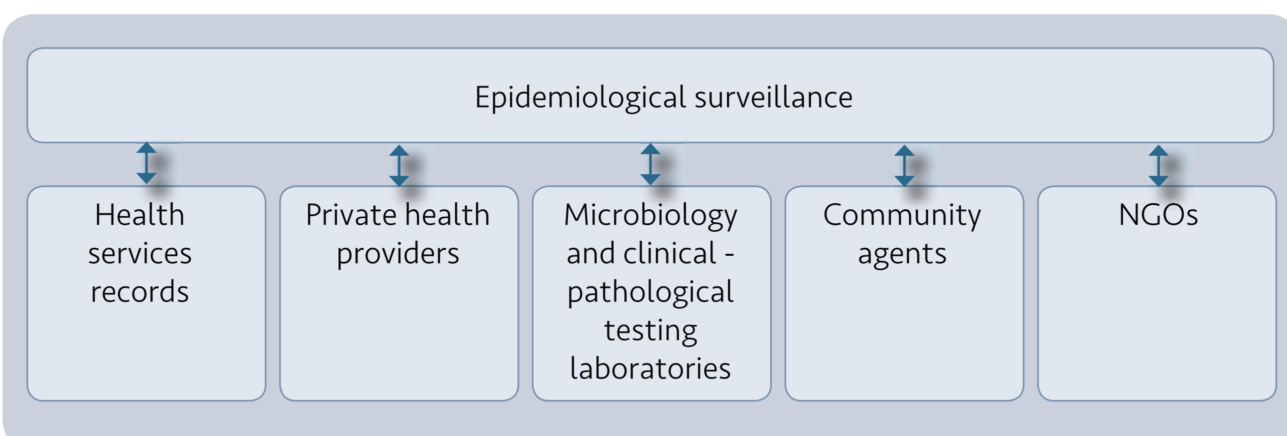
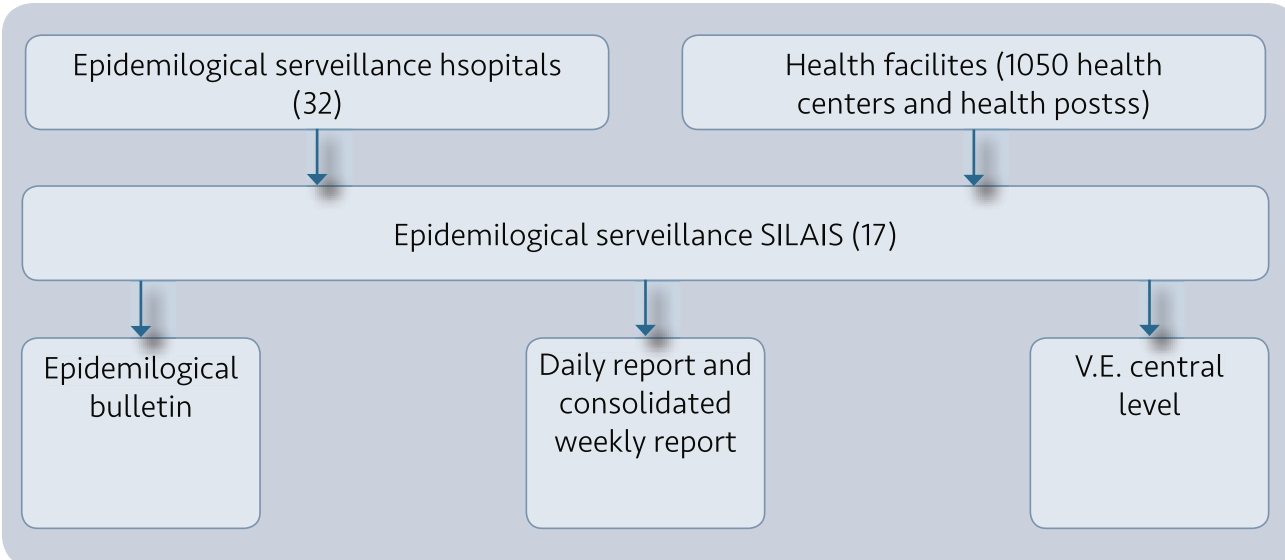


FIGURE 11: **Information flow chart**



Confirmed case: All suspected cases that have tested positive for dengue in a serological or virological test.

Role of hospitals, health centers, health posts, and volunteers

Hospitals: Diagnosis and management of cases, including taking samples and sending them to the corresponding laboratory; management of severe cases of dengue.

Health centers: Diagnosis and management of outpatient cases; follow up of positive cases and epidemic focus controls; implementation of vectoral control through the Vector Transmitted Disease (VTD) Program; educating the population.

Health posts: Identification, referral, or management of outpatient cases; educating the population.

Health volunteers: Referral of suspected cases and educating the population.

Examples of dengue control strategies

Managua

Implementation of the COMBI strategy, particularly in the municipality of Ticuantepe, revealed the following results:[39]

- Communities protected water tanks and barrels used to store water where there is an irregular supply, displaying intended behavioral changes of the strategy.
- Health promoters and interpersonal communication played an important role in the process of changing to healthy behaviors.
- The community exhibited a sense of greater self-efficacy in terms of controlling Aedes aegypti.
- The community actively participated in identifying options for reinforcing household actions (e.g., increasing the recommended frequency from once to twice a week to ensure the housewife performs the actions at least once a week).
- Schools used the Basic Dengue Booklet, particularly in the municipality of Ticuantepe and those sectors corresponding to the Pedro

Altamirano and Francisco Buitrago Health Centers.

Nueva Segovia

The COMBI project in the Santa Ana neighborhood of the municipality of Ocotal is characterized by actions aimed at protecting water resources through direct education.[40] This has resulted in a reduction of hydrically transmitted diseases and interruption of the life cycle of the Aedes aegypti vector. Community participation is essential for effectively implementing the actions, with community members carrying out the activities and the health personnel providing periodic training supervisions and entomologically measuring the results. The education actions are one of the main pillars of this process. They are implemented both directly, through visits to houses where the vector is located, and indirectly, using the media to congratulate people on the results obtained and thus encourage them to act in the interests of their own health.

The results show this intervention to be both effective and efficient. The initial block index of 70% at the beginning of 2007 fell to just 2% in December 2007, while the house index fell from 17.46 to 0.18, the deposit index from 2.12 to 0.02, and the Breteau index from 21.41 to 0.18. In gross numbers, the 84 houses that initially hosted the vector dropped to just one house in the whole neighborhood in December. The Santa Ana neighborhood was traditionally most affected by cases of dengue, but in 2008 dengue transmission was reduced starting from the 36th week, despite the fact that entomological data did demonstrate the presence of the vector. However, the presence detected was at a very low population density and was only in the larval stage, and there was no efficient transmission of the dengue virus.

Calculation of the cost of implementing this strategy in the whole municipality points to budgetary savings of approximately 60% compared to the cost of conventional measures (if the COMBI activities are carried out paying a per diem of 40.00 córdobas (about US$2), as the supervision is only done for half a day, once a week).

Chinandega

Health ministry personnel trained teachers in urban schools on dengue prevention based on the contents of the Basic Dengue Booklet.[41] After the training, follow up was provided through school visits to check whether the teachers were using the booklets with their pupils, while school competitions were held based on the students' knowledge of the contents. This has helped systematically integrate dengue prevention as a community and household responsibility into the school curriculum.

Funding mechanisms

The Ministry of Health assigns a budget for dengue control activities, providing resources for each SILAIS. Generally speaking, the country finances the salaries of 1,000 field workers across the country. An additional US$750,000 is spent each year on insecticides, while US$2,000,000 is earmarked to support the comprehensive control of contagious diseases, approximately 55% of which goes to the fight against dengue.[42] PAHO/WHO also provides financial collaboration of about US$25,000.

The sustainability of the dengue control strategies depends mainly on the financial capacity and the transfer of financial resources from the health ministry central level to the SILAIS.

Areas for improvement

The strategies for dengue prevention have produced good results. The most important challenge is to appropriately train MOH personnel so that all the activities are timely, prioritized, and of high quality.

Which nongovernmental agencies and other groups are involved in dengue eradication in Nicaragua?

Pan American Health Organization (PAHO): Provides technical and financial support.

Sustainable Sciences Institute: Since 1988 this nongovernmental organization has been working to help transfer appropriate technology to the CNDR and to strengthen research capabilities in this area. In 2003 it received funding from the Pediatric Dengue Vaccine Initiative to implement a sentinel site for dengue monitoring with a cohort of 5,000 children, in an attempt to discover the dynamics of dengue transmission, its clinical manifestation, and the severity of the disease. This sentinel site could be used in the future for the trial of a new dengue vaccine.

Conclusions

Dengue fever is a disease with a high risk of becoming epidemic in Nicaragua. Different macro factors influence the dengue problem in the country, requiring integrated efforts by public, private, and community sectors, which is vital to achieving the sustainability and complete effectiveness of the actions. In this respect, the Ministry of Health has implemented an integrated management strategy for dengue and has developed a number of successful local-level experiences.

In terms of diagnosis, progress has been made in decentralizing serological testing to the departmental level. However, the following challenges still remain:

1. Achieving more timely diagnosis of the cases when the symptoms first appear, as opposed to five days after they appear, as is currently the case. This recommendation is based on the fact that the patient must have been displaying the symptoms for five to seven days to confirm dengue using the main technology available—the IgM mono test for dengue. If the case is identified earlier than this, the patient must return for a future appointment, a practice that risks the patient not returning and health providers not being able to confirm the diagnosis. Rapid tests based on the detection of antigens could offer an alternative for detecting the disease earlier and can be easily taken to other at-risk communities that have not traditionally had access to laboratory services.

2. Reducing the time between taking the sample and receiving the results. Despite the decentralization efforts, the average time for obtaining a result for dengue is between 15 and 30 days, which is a long time and results in delayed control actions.

3. Achieving diagnosis of the vast majority of suspected cases that test negative for dengue. Only 30% of suspected dengue cases investigated test positive, which means that every year the etiology of about 8,000 febrile cases investigated for dengue is undetermined.

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41. Interview with Dr. Octavio Chávez, epidemiologist at the Chinandega SILAIS.

42. Interview with Dr. Juan José Amador, fomer MINSA Director of Epidemiology (1991-2007).

Appendix

TABLE A-1: **Dengue cases in Nicaragua, 2007–2008**

SILAIS	Confirmed cases of classic dengue, 2007	Confirmed cases of hemorrhagic dengue, 2007	Dengue incidence rate, 2007	Confirmed cases of classic dengue up to May 2008
Managua	444	94	3.15	54
N. Segovia	147	3	6.84	3
Matagalpa	149	2	2.47	21
León	139	13	3.52	11
Masaya	86	16	2.65	7
Chinandega	83	2	1.84	4
RSJ	55	0	5.63	8
Boaco	51	1	2.97	2
Carazo	50	8	2.97	2
Madriz	50	0	3.69	5
Jinotega	43	0	1.42	7
RAAS	37	1	3.33	1
Granada	21	5	1.08	1
RAAN	20	0	0.96	1
Estelí	20	1	0.91	0
Rivas	17	0	1	0
Chontales	3	4	0.07	0
TOTAL	1,415	156	2.53	127

TABLE A-2: **Total dengue tests conducted in the CNDR, 2006**

SILAIS	IgM			ELISA inhibition			RT-PCR			Viral Isolation			M/R/D		
	Total	Pos	%	Total	Pos	%	Total	Pos	%	Total	Pos	%	Total	Pos	%
Estelí	35	12	34	0	0	0	0	0	0	0	0	0	0	0	0
Madriz	444	45	10	0	0	0	0	0	0	0	0	0	5	0	0
N. Segovia	1141	140	12	0	0	0	29	8	28	0	0	0	3	0	0
Chinandega	862	103	12	0	0	0	13	0	0	0	0	0	8	0	0
León	249	31	12	0	0	0	29	4	14	0	0	0	7	1	14
Managua	3472	695	20	392	267	68	672	181	27	211	121	57	8	0	0
Granada	69	11	16	0	0	0	0	0	0	0	0	0	0	0	0
Carazo	170	64	38	0	0	0	1	0	0	1	1	100	6	0	0
Masaya	210	56	27	0	0	0	3	1	33	0	0	0	5	0	0
Rivas	25	3	12	0	0	0	0	0	0	0	0	0	1	0	0
Boaco	549	56	10	0	0	0	23	5	22	0	0	0	0	0	0
Chontales	73	3	4	0	0	0	0	0	0	0	0	0	3	0	0
Matagalpa	17	3	18	0	0	0	0	0	0	0	0	0	2	0	0
Jinotega	388	54	14	0	0	0	6	0	0	0	0	0	7	0	0
RAAN	92	20	22	0	0	0	1	0	0	0	0	0	0	0	0
RAAS	21	5	24	0	0	0	0	0	0	0	0	0	0	0	0
R.S. Juan	458	49	11	0	0	0	15	2	13	0	0	0	0	0	0
Total	8275	1350	16	392	267	68	792	201	25	212	122	58	55	1	2

FIGURE A-1: **Management of patients with dengue**

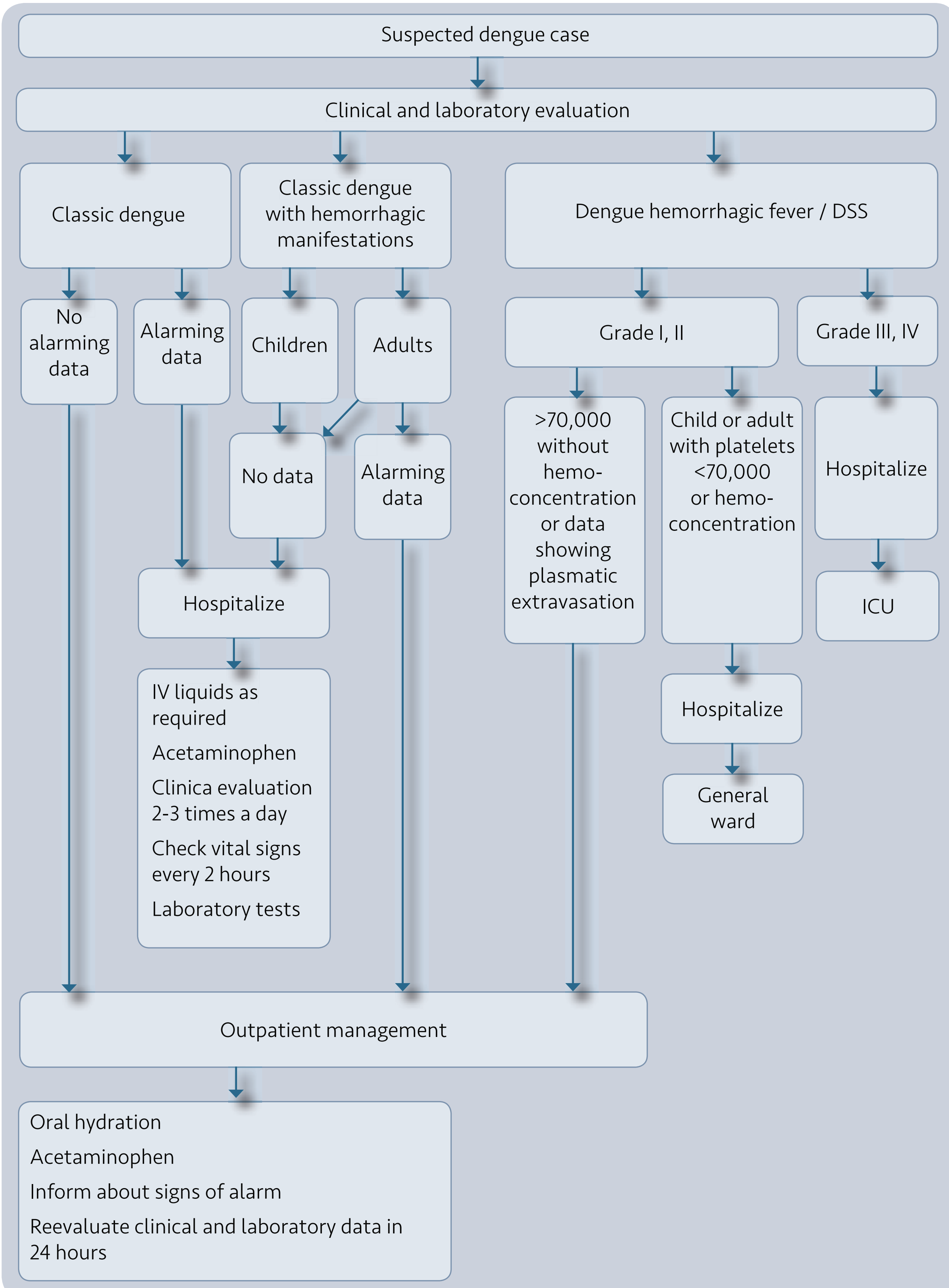
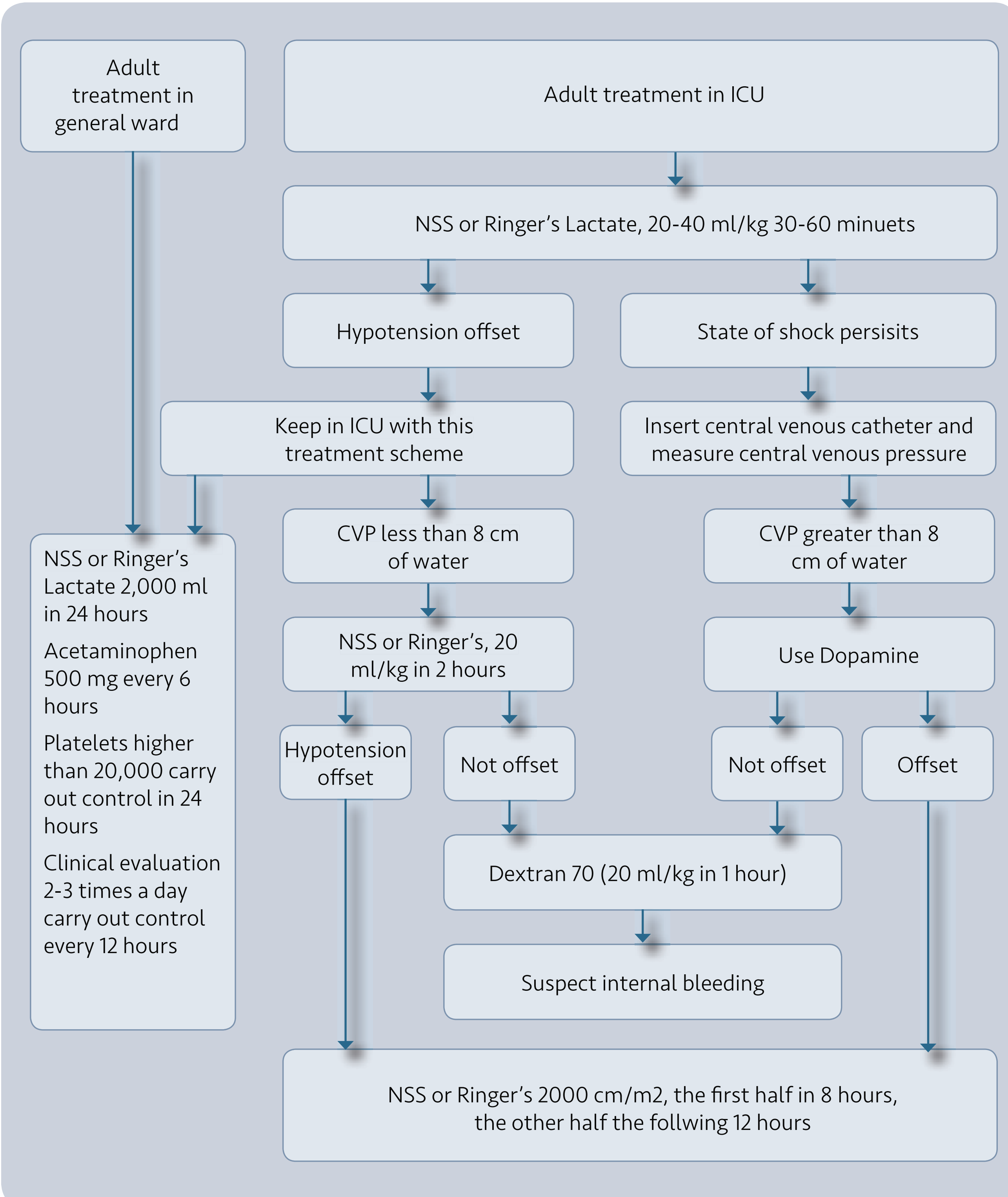


FIGURE A-2: **Hospital treatment for adults**



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