A Clinical Review of Congenital and Perinatal Infections: From Womb to Follow-Up

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EDUCATION GAPS

Although TORCH (*Toxoplasma gondii*, others, rubella virus, cytomegalovirus, and herpes simplex virus) infections are well-recognized causes of congenital anomalies, many clinicians lack up-to-date knowledge regarding diagnostic algorithms, interpretation of serologic testing, and the timing of maternal-fetal transmission. Misconceptions surrounding immunoglobulin M (IgM) positivity, limited awareness of avidity testing, and insufficient familiarity with available treatment options can lead to delays in appropriate clinical interventions. Furthermore, geographic variability in screening guidelines and inadequate prenatal counseling contribute to inconsistencies in management. A clear understanding of the epidemiology, transmission risks, and potential sequelae associated with each TORCH agent is essential for improving perinatal outcomes and preventing lifelong morbidity in affected neonates.

OBJECTIVES *After completing this article, readers should be able to:*

1. Identify the major pathogens classified under TORCH (*Toxoplasma gondii*, others, rubella virus, cytomegalovirus, and herpes simplex virus) infections and describe their modes of transmission and effects on the fetus.
2. Accurately interpret maternal and neonatal serologic tests and recognize the role of polymerase chain reaction tests and imaging in the diagnosis of congenital infections.
3. Apply evidence-based treatment protocols specific to each TORCH agent and assess the need for antiviral or antimicrobial therapy.
4. Plan long-term follow-up and developmental surveillance for infants diagnosed with congenital TORCH infections.
5. Integrate preventive strategies such as vaccination and maternal education into routine obstetric and neonatal care.

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ABBREVIATIONS

AAP	American Academy of Pediatrics
ABR	auditory brainstem response
ART	antiretroviral therapy
CBC	complete blood cell count
CMV	cytomegalovirus
CNS	central nervous system
CSF	cerebrospinal fluid
CT	computed tomography
HSV	herpes simplex virus
IgG	immunoglobulin G
IgM	immunoglobulin M
IM	intramuscular
IV	intravenous
PCR	polymerase chain reaction
RPR	rapid plasma reagin
TORCH	*Toxoplasma gondii*, others, rubella virus, cytomegalovirus, and herpes simplex virus
US	ultrasonography
VZV	varicella-zoster virus

ABSTRACT

The acronym "TORCH" was originally introduced in 1974 by Dr Nahmias to collectively describe the most common pathogens responsible for congenital and perinatal infections, including *Toxoplasma gondii*, others, rubella virus, cytomegalovirus (CMV), and herpes simplex virus. With advances in diagnostic capabilities and expanded epidemiologic surveillance, the list of recognized congenital pathogens has grown to include syphilis, varicella-zoster virus, Zika virus, HIV, parvovirus B19, and lymphocytic choriomeningitis virus. While the TORCH acronym continues to be widely used in clinical and educational settings, it no longer encompasses the full spectrum of pathogens implicated in perinatally acquired and in utero infections. A more nuanced and inclusive approach to the diagnosis and management of congenital infections is required. These vertically transmitted pathogens can disrupt fetal development, leading to outcomes ranging from subclinical disease to severe neurologic impairment, sensorineural hearing loss, or fetal demise. Epidemiologic trends vary globally: CMV is more prevalent in low-income countries, while congenital rubella is rare in regions with successful vaccination programs. The Zika virus outbreak underscored the need for early recognition of emerging threats to fetal health. Despite their potentially serious consequences, TORCH infections are frequently underdiagnosed due to nonspecific clinical presentations, diagnostic limitations, and inconsistencies in screening practices. Misinterpretation of serologic results and delays in diagnosis may lead to preventable complications. This review synthesizes current evidence on TORCH infections, emphasizing clinical manifestations, diagnostic strategies, therapeutic approaches, and long-term follow-up. A proposed multidisciplinary model aimed at improving perinatal screening and neonatal outcomes is offered.

CLINICAL CONSIDERATIONS

Epidemiology and Etiology

TORCH is an acronym first introduced by Nahmias in 1974 to describe a group of infections transmitted from mother to fetus during pregnancy or at birth, potentially leading to severe fetal anomalies, developmental disorders, or neonatal death.[1] This group includes the following pathogens:

- Toxoplasmosis (*Toxoplasma gondii*)
- Other agents (eg, syphilis, HIV, parvovirus B19, varicella-zoster virus [VZV], Zika virus)
- Rubella
- Cytomegalovirus (CMV)
- Herpes simplex virus (HSV)

When contracted during pregnancy—especially in the first trimester—these infections can profoundly disrupt fetal development, resulting in a wide range of clinical outcomes from neurodevelopmental impairment to spontaneous miscarriage.[2] Accurate recognition and understanding of TORCH infections are critical for both prenatal monitoring and neonatal evaluation.[3]

Prevalence and Regional Variations

The prevalence of TORCH infections varies significantly depending on geographic region, socioeconomic status, hygiene conditions, and the effectiveness of local health care systems.[4]

Toxoplasmosis. Toxoplasmosis, caused by *T gondii*, is a parasitic infection. Seroprevalence ranges from 10% to 30% in developed countries but can reach 50% to 80% in developing regions such as South America, Africa, and Southeast Asia.[5] Risk factors include consumption of raw or undercooked meat, poor hygiene, and contact with soil contaminated by cat feces.[6]

CMV. CMV is among the most common causes of congenital infections. Global CMV seroprevalence ranges from 60% to 100%.[7] In low- to mid-income countries, CMV infection is often acquired during childhood, whereas in high-income countries, up to 40% of test results in women of childbearing age remain seronegative, increasing the risk of primary infection during pregnancy.[8]

Rubella. Rubella is a vaccine-preventable viral infection. In countries with successful immunization programs, congenital rubella syndrome has been virtually eliminated. However, outbreaks still occur in regions with insufficient vaccine coverage or conflict zones, where it can cause significant congenital anomalies.[9]

HSV. HSV is a viral infection primarily transmitted during delivery. HSV-1 has a global prevalence of approximately 60% to 70%, while HSV-2, which is more commonly associated with genital infection, is sexually transmitted. Although neonatal herpes is rare (1 in 3000 to 1 in 20 000 live births), it carries high morbidity and mortality.[10]

Elective cesarean delivery in women with active genital HSV lesions has been shown to significantly reduce the risk of intrapartum neonatal transmission.[11]

Other infections and the expanding TORCH spectrum. The "other" category within the TORCH acronym encompasses several vertically transmitted infections, including syphilis, HIV, parvovirus B19, VZV, and Zika virus. Among these, syphilis has shown a concerning resurgence in several countries, with rising rates of congenital syphilis reported globally.[12,13] Zika virus, in particular, gained international attention following the 2015–2016 outbreak in Latin America, where Zika infection was strongly associated with microcephaly and other severe congenital anomalies.[14,15]

Although Zika virus is not part of the original TORCH classification (*T gondii*, other [primarily syphilis], rubella, CMV, and HSV), it has increasingly been included in the broader category of TORCH-like infections. This is due to its well-established ability to cross the placenta and cause significant fetal neurodevelopmental harm. As a result, recent literature and clinical guidelines have proposed expanded terminologies such as "TORCHZ" or "STORCH" to reflect its inclusion.[16] In line with this evolving perspective, this review includes Zika virus due to its substantial congenital impact and relevance to modern perinatal infectious disease management.

Differences Between High-Income and Low- and Middle-Income Countries

In high-income countries, the control of TORCH infections is more effectively achieved through widespread vaccination programs (eg, rubella), access to quality health care services, and hygienic living conditions.[17] Additionally, prenatal screening tests commonly used during pregnancy allow for early detection of these infections, thereby reducing the risk of congenital transmission and preventing postnatal complications.[18]

In contrast, in low- and middle-income countries, the prevalence and transmission risk of TORCH infections are significantly higher due to limitations in health care infrastructure, inadequate prenatal care, lack of routine screening, and lower vaccination coverage. For instance, the rate of congenital CMV transmission is estimated to be approximately 10 times higher in low- and middle-income countries compared with developed regions.[19]

Routes of Vertical Transmission

TORCH pathogens can be transmitted to the fetus through 3 primary routes:

1. Transplacental (hematogenous) transmission: Pathogens such as *T gondii*, rubella virus, and CMV can cross the placenta and reach the fetus directly. This is the most common route of vertical transmission.[20]
2. Intrapartum (perinatal) transmission: Agents such as HSV and CMV can be transmitted during passage through the birth canal.[21]
3. Postnatal transmission (via breastfeeding): This route is particularly relevant for CMV and HIV infections. The 2020 guidelines by the American Academy of Pediatrics (AAP) Committee on Pediatric AIDS underscore that breastfeeding remains a potential route of vertical HIV transmission, particularly in the absence of maternal viral suppression.[22] Breastfeeding is particularly relevant for CMV and HIV, where infectious agents can be passed through breast milk.[23]

The timing of maternal infection plays a critical role in determining the severity of fetal outcomes. Infections contracted during the first trimester—coinciding with the period of organogenesis—are more likely to result in severe fetal anomalies, whereas infections occurring in the third trimester tend to have milder clinical presentations.[24]

Given the etiologic diversity and epidemiologic dynamics of TORCH infections, a comprehensive approach is essential in pregnancy management and neonatal care. Strengthening screening and immunization programs in low- and middle-income regions is pivotal to reducing the associated morbidity and mortality. Aligning global health policies with these priorities will be instrumental in improving the quality of prenatal care, particularly among at-risk populations.[25]

A comparative overview of clinical features, transmission routes, diagnostic methods, and therapeutic options for TORCH agents is presented in Table 1.

PATHOGENESIS AND FETAL EFFECTS

The timing of maternal infection plays a crucial role in determining the severity and likelihood of fetal transmission for each congenital infection.

For HIV, the risk of vertical transmission is highly dependent on maternal viral load and antiretroviral therapy (ART) adherence. Transmission risk is lowest when maternal viral suppression is achieved before conception and throughout pregnancy. While HIV can be transmitted during pregnancy, delivery, or breastfeeding, exclusive breastfeeding combined with maternal ART and infant prophylaxis is recommended in resource-limited settings, whereas in high-resource countries, formula feeding is typically advised.[26,27]

TABLE 1. Clinical Features and Diagnostic Tools for TORCH Infections

Pathogen	Typical Clinical Findings	Preferred Diagnostic Method	Notes
Toxoplasma gondii	Chorioretinitis, hydrocephalus, intracranial calcifications	IgM/IgG serology, PCR (amniotic fluid)	Use IgG avidity (binding strength) to assess timing of infection
Rubella virus	Cataracts, sensorineural hearing loss, patent ductus arteriosus	PCR (blood/urine), IgM/IgG	Test maternal serology if suspicion arises
CMV	Microcephaly, periventricular calcifications, hearing loss	PCR (urine/saliva) within 21 d of life	Serology unreliable in neonates
HSV	Vesicular lesions, encephalitis, hepatic failure	PCR (CSF, skin), culture	Start empirical acyclovir in symptomatic neonates
Syphilis (*Treponema pallidum*)	Snuffles, rash, hepatosplenomegaly	RPR test/VDRL (infant and maternal), TPHA	Compare maternal and infant RPR titers
HIV	Asymptomatic at birth, late-onset immunosuppression	HIV-1 PCR (blood)	Serology unreliable; ART

Notes: Rubella: highest teratogenic risk during first trimester. CMV: sensorineural hearing loss risk increases with second or third trimester infection. Toxoplasmosis: more severe central nervous system findings when infection occurs early in pregnancy.
Abbreviations: ART, antiretroviral therapy; CMV, cytomegalovirus; CSF, cerebrospinal fluid; HSV, herpes simplex virus; IgM/IgG, immunoglobulin M/immunoglobulin G; PCR, polymerase chain reaction; RPR, rapid plasma reagin; TPHA, *Treponema pallidum* hemagglutination assay; VDRL, venereal disease research laboratory test.

The risk of neonatal HSV infection is closely linked to the timing and nature of maternal infection. Primary maternal HSV infection during the third trimester presents the highest risk of vertical transmission, primarily due to the lack of protective maternal antibodies.[11] In contrast, recurrent (secondary) infections confer a considerably lower transmission risk, as transplacental maternal antibodies provide partial immunity to the neonate. The presence of active genital lesions or prodromal symptoms at the onset of labor constitutes a strong indication for cesarean delivery to minimize the likelihood of intrapartum transmission. In asymptomatic women with a known history of recurrent HSV, vaginal delivery remains an acceptable option. To further reduce the risk of asymptomatic viral shedding, suppressive antiviral therapy, typically initiated at 36 weeks of gestation, is recommended in women with a history of genital HSV.[28]

The pathogenesis of TORCH infections varies depending on the characteristics of the causative microorganism and the gestational age at which maternal infection occurs. Infections acquired during the early stages of pregnancy, particularly during the period of organogenesis in the first trimester, are associated with more severe fetal consequences due to the rapid development and differentiation of embryonic tissues. In contrast, infections occurring in the third trimester often result in milder clinical manifestations, although some pathogens can still cause significant neonatal complications even in late pregnancy.[25]

For instance, rubella virus infection during the first 8 to 10 weeks of gestation can lead to the classic manifestations of congenital rubella syndrome, including congenital heart defects, cataracts, sensorineural hearing loss, and microcephaly.[9] Similarly, CMV infection in early pregnancy may result in severe neurodevelopmental impairment and permanent damage.[8] *T gondii* infection may lead to spontaneous abortion in early gestation, and surviving fetuses are at risk for severe ocular and neurologic abnormalities.[5]

TORCH agents may directly invade fetal cells, inducing cell death, impairing cell proliferation, or disrupting tissue organization, thereby exerting teratogenic effects. These impacts are particularly pronounced in rapidly developing fetal organ systems, such as the brain, eyes, heart, and liver. For example, Zika virus exhibits a strong tropism for fetal brain tissue, resulting in microcephaly and profound cortical malformations.[14] CMV can cause periventricular calcifications, ventriculomegaly, and sensorineural hearing loss as lasting sequelae.[7]

The fetal immune system is immunologically immature and incapable of mounting an adequate defense against TORCH pathogens. Maternal-fetal immune interactions also influence the extent of fetal damage. While maternal antibodies may cross the placenta and confer some protection, this is not always sufficient—particularly in cases of primary maternal infection, in which the fetal exposure may occur before a robust maternal immune response has developed.[3]

Although the placenta serves as a critical barrier against fetal infection, many TORCH pathogens can breach this defense. For example, CMV can infect placental cells and replicate within endothelial and stromal tissues. *T gondii* traverses the trophoblast layer to reach the fetal circulation.[6] While HSV and HIV are more commonly transmitted intrapartum or postnatally, intrauterine transmission has also been reported in rare instances.

In summary, the pathogenesis of TORCH infections is a complex interplay of factors, including the timing of

infection, pathogen virulence, maternal immune status, and placental permeability. Evaluating infections based on gestational timing is therefore essential for prognosis prediction and provides valuable guidance for prenatal counseling and management.

DIAGNOSIS

Diagnosing TORCH infections requires a pathogen-specific and time-sensitive approach, as clinical manifestations are often nonspecific and vary according to the timing of fetal exposure. An evidence-based overview of the recommended diagnostic strategies by pathogen is presented in Table 2 below.

Serologic Testing and IgG Avidity

Serologic tests (immunoglobulin M [IgM] and G [IgG]) remain central to prenatal screening. However, IgM may yield false positives, and maternal IgG crosses the placenta, complicating interpretation. For infections such as CMV and *Toxoplasma*, IgG avidity (strength of the bond between IgG antibody and pathogen) testing is crucial when infection timing is unclear:

- Low avidity: primary infection within previous 2 to 4 months (high fetal risk)
- High avidity: past infection; low risk to fetus

PCR: Gold Standard for Direct Detection

Polymerase chain reaction (PCR) testing is increasingly favored due to its sensitivity and specificity:

- CMV: PCR on urine/saliva within 21 days
- *Toxoplasma*: PCR on amniotic fluid
- HSV: PCR on cerebrospinal fluid (CSF), lesion swabs
- HIV: PCR on blood-specific type of nucleic acid test at defined intervals[27]

What Is a "TORCH Panel"?

A typical TORCH panel includes serologic testing for *T gondii*, rubella, CMV, and HSV, although the utility of such panels is increasingly debated. Clinically, a TORCH panel should not refer to a fixed test set. Instead, a diagnostic approach should be guided by maternal history and serologies, infant signs, and epidemiologic context.

Overtesting with a complete "panel" may delay or confuse diagnosis. Instead, targeted testing based on clinical suspicion and exposure history is preferred—a principle known as diagnostic stewardship.

Additional Tests Based on Infection

- Neuroimaging (ultrasonography [US], magnetic resonance imaging, computed tomography [CT]): CMV, *Toxoplasma*, Zika
- Ophthalmologic examination: *Toxoplasma*, rubella, CMV
- Hearing evaluation (auditory brainstem response [ABR]): CMV, rubella
- Long-bone radiographs: syphilis
- Complete blood cell count (CBC), platelets, liver enzyme tests: CMV, HSV, rubella, syphilis

MANAGEMENT AND TREATMENT

CMV

- When to treat: only symptomatic neonates
- Drugs: intravenous (IV) ganciclovir followed by oral valganciclovir
- Duration:

TABLE 2. Recommended Diagnostic Strategies by Pathogen

Pathogen	What to Test	Sample	Timing	Notes
CMV	PCR	Urine or saliva	Within first 21 d of life	Serologic tests are unreliable in neonates. PCR is gold standard for congenital CMV; testing results beyond day 21 may reflect postnatal acquisition.
HSV	PCR ± viral culture	Lesional swab, CSF, blood	≥24 h after birth	Test all symptomatic neonates and those born to mothers with active lesions. CSF PCR for CNS involvement.
HIV	HIV-1 PCR (NAT)	Whole blood (collected in EDTA tubes)	Day 0, 14, 28, and beyond	Serologic tests are unreliable due to maternal antibodies. Use PCR at multiple time points.
Syphilis	RPR/VDRL, TPHA	Maternal and neonatal serum	At birth	Compare neonatal RPR titer with maternal: ≥4-fold higher indicates congenital infection. Treponemal tests confirm past exposure.
Toxoplasma	IgM, IgG, IgG avidity, PCR	Maternal serum, fetal amniotic fluid	Any time during pregnancy	IgG avidity testing is essential in early pregnancy; low avidity suggests recent infection. Fetal PCR via amniocentesis confirms diagnosis.

Abbreviations: CMV, cytomegalovirus; CNS, central nervous system; CSF, cerebrospinal fluid; HSV, herpes simplex virus; IgM, immunoglobulin M; NAT, nucleic acid test; PCR, polymerase chain reaction; RPR, rapid plasma reagin; TPHA, *Treponema pallidum* hemagglutination assay; VDRL, venereal disease research laboratory test.

- 6 weeks: for isolated hearing loss
- 6 months: According to the 2024 AAP Red Book, symptomatic infants with congenital CMV should receive oral valganciclovir for up to 6 months to mitigate neurodevelopmental delays and progressive hearing loss.[29]

- Goal: prevent progression of hearing loss and neurodevelopmental delays
- Monitoring: CBC (for neutropenia), liver enzymes, and serial hearing and developmental assessments[30]

HSV

- When to treat: any symptomatic neonate or perinatal exposure with clinical suspicion
- Drugs:
  - IV acyclovir 20 mg/kg/dose every 8 hours
  - Oral acyclovir for suppressive therapy
- Duration:
  - 14 to 21 days IV depending on disease type
  - 6 months' oral prophylaxis
- Goal: eradicate viral replication and prevent relapse and long-term neurologic impairment
- Monitoring: serial CSF HSV PCR, liver function, absolute neutrophil count[31]

HIV

- When to treat: all exposed neonates
- Drugs: zidovudine with or without nevirapine or other ART based on risk
- Duration:
  - 4 to 6 weeks' prophylaxis (low risk)
  - Full ART if high risk or PCR positive
- Goal: prevent vertical transmission and achieve viral suppression
- Maternal factors: viral load, adherence to ART, delivery mode

Syphilis

- When to treat:
  - Based on infant's rapid plasma reagin (RPR) test results compared with mother's RPR test results
  - If maternal treatment is inadequate or unknown
- Drugs: penicillin G (intramuscular [IM] or IV)
- Duration:
  - 10 days' IV (symptomatic or uncertain cases)
  - Single IM dose if evaluation result is normal and maternal treatment reliable
- Goal: eradicate spirochetes and prevent late complications (bone, central nervous system [CNS])
- Monitoring: serial RPR test every 2 to 3 months until test results are negative

Toxoplasmosis

- When to treat:
  - During pregnancy: if maternal seroconversion confirmed
  - Neonate: if congenital infection diagnosed or strongly suspected
- Drugs:
  - Spiramycin (antenatal, <18 weeks, noninfected fetus)
  - Pyrimethamine + sulfadiazine + folinic acid (fetal or neonatal infection)
- Duration: 12 months or more postnatally
- Goal: prevent CNS and ocular sequelae
- Monitoring: blood counts, eye examinations, brain imaging, auditory testing[32]

Rubella

- When to treat: No antiviral therapy exists
- Management: supportive care only
- Preventive goal: through maternal measles-mumps-rubella vaccination

Multidisciplinary and Prenatal Considerations

- Management during pregnancy includes counseling, timely fetal imaging, and potential off-label antiviral use (eg, CMV).
- Delivery mode and prophylaxis depend on pathogen (eg, cesarean delivery for HSV if active lesions).
- Multidisciplinary coordination among obstetrics, neonatology, infectious diseases, and social work is essential.
- Family counseling and long-term follow-up planning should be initiated early.

PROGNOSIS AND FOLLOW-UP

TORCH infections may present with overt signs and symptoms during the neonatal period, or they may remain clinically silent until long-term sequelae become apparent over the following months or years. The CNS, auditory system, and visual pathways are among the most commonly affected structures. Therefore, long-term follow-up is critical for both symptomatic and asymptomatic infants and should be conducted within structured surveillance protocols.

Long-Term Sequelae

Congenital TORCH infections can lead to a variety of serious outcomes, including neurodevelopmental delay, motor coordination deficits, epilepsy, hearing loss, visual impairment, and learning disabilities.[19,33] For example, CMV infection is the most common infectious cause of sensorineural hearing loss in children.[4] Similarly, in congenital toxoplasmosis, ocular involvement such as chorioretinitis may result

TABLE 3. Recommended Follow-Up for Infants With Congenital Infections

Category	Details
Cytomegalovirus	
Follow-up recommendations	Serial hearing tests, brain MRI, neurodevelopmental assessment
Recommended duration	≥5 y
Herpes simplex virus	
Follow-up recommendations	Auditory brainstem response, neurologic monitoring
Recommended duration	≥6 mo to 2 y
Toxoplasmosis	
Follow-up recommendations	Fundoscopy, MRI, EEG
Recommended duration	At least 1 y
Syphilis	
Follow-up recommendations	RPR monitoring until nonreactive
Recommended duration	Up to 6–18 mo
HIV	
Follow-up recommendations	PCR, CD4 count, viral load monitoring
Recommended duration	Lifelong if test results are positive

Abbreviations: EEG, electroencephalogram; MRI, magnetic resonance imaging; PCR, polymerase chain reaction; RPR, rapid plasma reagin.

in progressive vision loss.[34] Rubella infection is associated with both hearing and visual deficits, often accompanied by cognitive or developmental impairments.[35]

Hearing, Neurodevelopmental, and Visual Surveillance

A multidisciplinary follow-up approach should be implemented for all infants diagnosed with TORCH infections from birth onward, as described in the following sections.

Hearing. Newborns should undergo automated ABR screening at birth. Infants with abnormal findings should be referred for comprehensive audiologic evaluation. As hearing loss may have a delayed onset, annual monitoring is recommended throughout early childhood.[36]

Neurodevelopment. Regular developmental screening tests should assess motor, cognitive, and language skills. Children with identified delays should be enrolled in early intervention programs as soon as possible.[37]

Vision. Fundoscopic examination can help identify complications such as chorioretinitis or optic atrophy. Ophthalmologic follow-up is particularly important for infants with a history of toxoplasmosis or rubella.[9]

Screening Protocols

While there is no universal screening program for TORCH infections, targeted evaluations are recommended in high-risk neonates. In the prenatal period, diagnosis may be achieved through maternal serology, fetal US, and amniotic fluid PCR.[3] Postnatally, assessment typically includes a TORCH panel, hearing screening, and neuroimaging. The screening strategy should be individualized based on clinical presentation and epidemiologic risk factors.[38]

Early identification and monitoring of TORCH-related sequelae directly impact long-term health outcomes and quality of life. Therefore, a comprehensive follow-up protocol

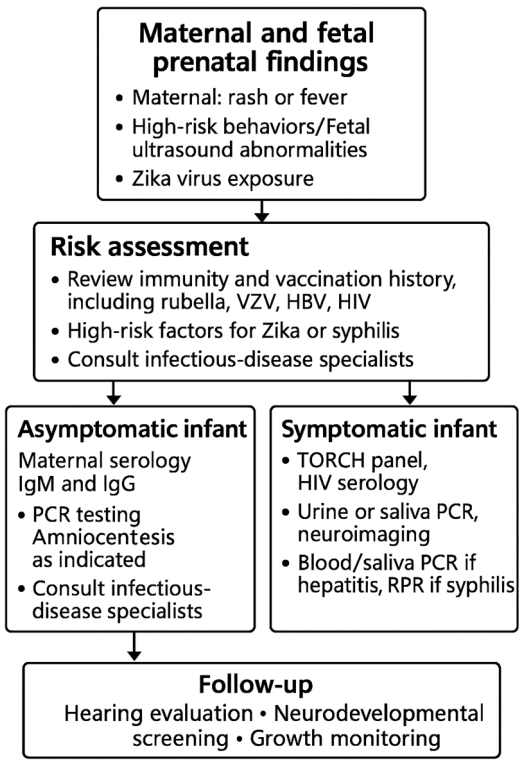

FIGURE 1. A flowchart diagram depicts the diagnostic pathway for infants with suspected congenital or perinatal infections, incorporating prenatal findings, maternal evaluation, infant symptomatology, and follow-up assessments.
Abbreviations: IgM, immunoglobulin M; PCR, polymerase chain reaction; TORCH, *Toxoplasma gondii*, others, rubella virus, cytomegalovirus, and herpes simplex virus; VZV, varicella-zoster virus.

involving specialists in pediatrics, neurology, audiology, ophthalmology, and developmental medicine is essential for optimal care.[39] A structured postnatal surveillance protocol based on clinical presentation and exposure history is presented in Table 3.

CONCLUSION

TORCH infections represent a significant subgroup of congenital infections. These pathogens can be transmitted from mother to fetus during pregnancy or at the time of delivery, leading to substantial morbidity, mortality, and long-term sequelae. The timing of diagnosis and a multidisciplinary approach are critical in guiding effective clinical management (Figure 1). This review addresses major TORCH pathogens, covering their epidemiology, pathogenesis, clinical manifestations, diagnostic strategies, treatment options, and follow-up protocols.

Summary

The following clinical insights summarize key considerations for timely diagnosis, targeted treatment, and effective follow-up of TORCH infections:

- TORCH infections pose the greatest risk to the fetus when acquired during early pregnancy. (Based on strong research evidence)[2]
- The most common sequelae include sensorineural hearing loss, neurodevelopmental delay, and visual impairment. (Based on strong research evidence)[40–42]
- Timing is critical in diagnosis—an integrated approach combining prenatal serology, fetal imaging, and postnatal evaluation is essential. (Based on consensus due to lack of randomized controlled trials)[27,43]
- While prenatal treatment options for toxoplasmosis and CMV are limited, early postnatal therapy can reduce long-term complications. (Based on strong research evidence)[44,45]
- Infections such as rubella and HIV can be largely prevented through vaccination and antenatal ART, respectively. (Based on strong research evidence)[27,46]
- Family counseling and long-term follow-up are indispensable components of comprehensive care. (Based on some research evidence and expert consensus)[40,47]
- Applying evidence-based management protocols for each TORCH agent improves clinical outcomes. (Based on strong research evidence)[11]

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PIR QUIZ

1. A 2-day-old girl born by vaginal delivery at 38 weeks' gestation is noted to have a cluster of vesicular lesions with surrounding erythema on the scalp. The mother had rupture of membranes 30 hours prior to delivery. The mother denies a history of genital herpes. Which of the following is the most likely mode of transmission for the skin lesions?

   A. Intrauterine in the first trimester.
   B. Intrauterine in the third trimester.
   C. Perinatal (intrapartum).
   D. Postpartum.

2. A 25-year-old pregnant woman presents to the emergency department in acute labor, and the baby is delivered vaginally. Gestational age is assessed to be 34 weeks. The mother had no prenatal care but states she had "flu" in the first trimester. The mother's immunization history is unknown. The baby is noted to have hydrocephalus, hepatomegaly, and splenomegaly. A head CT scan notes diffuse calcifications. A retinal examination shows chorioretinitis. Auditory evoked responses are normal. Cerebrospinal fluid testing found elevated protein level and pleocytosis. The baby develops seizures on day 1 of life. Which of the following is the most likely pathogen?

   A. Cytomegalovirus.
   B. Rubella virus.
   C. *Toxoplasma gondii*.
   D. *Treponema pallidum*.

3. A 1-day-old boy born by vaginal delivery at 37 weeks' gestation is evaluated in the nursery for jaundice. Pregnancy was complicated by intrauterine growth retardation. The baby is small for gestational age and microcephalic. CBC findings are remarkable for thrombocytopenia. Total bilirubin is 12 mg/dL with conjugated bilirubin of 6.8 mg/dL. Head US reveals periventricular calcifications. Auditory evoked responses are abnormal bilaterally. Retinal examination results are normal. Which of the following is the most appropriate test to confirm the diagnosis?

   A. Blood HSV (Herpes simplex virus) PCR.
   B. Serum CMV (cytomegalovirus) IgG.
   C. TORCH antibody panel.
   D. Urine CMV PCR.

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4. A girl is born by vaginal delivery, average for gestational age at 39 weeks' gestation, to a 24-year-old G2P1 mother with a history of HIV infection that was diagnosed 2 years ago. Since her HIV diagnosis, she has been receiving antiretroviral therapy. Her HIV viral load has been undetectable prior to this pregnancy and throughout her pregnancy to include testing 2 weeks ago and the day prior to delivery. Apgar scores are 9 and 9, and the baby's physical examination results are normal. The mother does not wish to breastfeed, so the baby is formula fed. The mother also had an undetectable HIV viral load measured the day of delivery. Which of the following is the most appropriate antiretroviral for the baby?

   A. Lamivudine, raltegravir, and zidovudine.
   B. Lamivudine and raltegravir.
   C. No antiretroviral therapy is indicated because the mother had undetectable HIV PCR tests.
   D. Zidovudine.

5. A boy is born by vaginal delivery, average for gestational age at 38 weeks' gestation, to a 22-year-old G1 mother. Apgar scores are 8 and 9. At mother's first prenatal visit at in the first trimester, her rapid plasma reagin (RPR) was reactive at 1:4 with a test result positive for treponemal antibodies. The county health department confirms the mother was appropriately treated for latent syphilis with 3 doses of benzathine penicillin. A follow-up RPR finding on the mother 2 weeks ago was 1:2, and just prior to delivery, the mother had an RPR finding of 1:2. The baby's physical examination results are normal. The baby's RPR finding is reactive at 1:1 and thus is less than the mother's RPR finding. The baby receives a dose of IM benzathine penicillin prior to discharge. Which of the following postdischarge follow-up plans is recommended for the baby?

   A. RPR test in 1 year.
   B. RPR test in 2 to 3 months.
   C. Treponemal antibody test in 1 year.
   D. Treponemal antibody test in 6 months.