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THE IMPORTANCE OF EARLY DETECTION OF TORCH INFECTIONS

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ABSTRACT: Early detection of TORCH infections—encompassing Toxoplasma gondii, Other agents (e.g., syphilis, varicella-zoster, parvovirus B19), Rubella virus, Cytomegalovirus (CMV), and Herpes simplex virus (HSV)—is critical to reducing adverse fetal and neonatal outcomes. This narrative review synthesizes evidence on the importance and impact of early detection strategies for TORCH pathogens during pregnancy and in neonates. A comprehensive search was conducted in PubMed/MEDLINE, Google Scholar, Embase, and key organizational websites (WHO, CDC, professional society guidelines) for literature published from January 2010 to May 2025, using combinations of "TORCH," "early detection," "prenatal screening," "diagnosis," and related terms. Inclusion criteria comprised studies addressing diagnostic modalities, timing of detection, management implications, and outcome data; exclusion criteria included case reports without focus on diagnostic timing or outcomes. Findings indicate that early detection via maternal serology, targeted ultrasound, PCR of amniotic fluid, and neonatal screening can substantially mitigate morbidity: for example, timely identification of congenital toxoplasmosis with prompt therapy reduces sequelae; syphilis screening in the first trimester nearly eliminates congenital syphilis; early CMV detection informs monitoring though specific interventions remain limited; antenatal identification of primary HSV infection aids delivery planning to reduce neonatal transmission. However, universal TORCH panel screening in low-risk asymptomatic women is not uniformly recommended due to cost-effectiveness concerns and variable prevalence; targeted screening based on risk factors or ultrasound findings is often advised. Barriers include resource limitations, asymptomatic maternal infections, and gaps in awareness. Integration of early detection into routine antenatal care, with algorithmic approaches combining serology, imaging, and molecular diagnostics, is essential to optimize maternal–fetal health. Continued research should refine cost-effectiveness of universal versus targeted approaches, enhance diagnostic accuracy (e.g., novel biomarkers, improved PCR assays), and evaluate interventions following early detection to further reduce the burden of TORCH-related morbidity.

Keywords: TORCH infections, Early detection, Prenatal screening, Maternal serology, Congenital infection, Molecular diagnostics, Neonatal outcomes, Antenatal diagnosis

INTRODUCTION

TORCH infections collectively contribute to a significant proportion of congenital disorders worldwide, estimated at approximately 2–3% of congenital anomalies and a notable share of perinatal morbidity and mortality. These infections are often asymptomatic or present with mild maternal illness, yet may cause severe fetal outcomes including miscarriage, stillbirth, intrauterine growth restriction, neurodevelopmental impairment, sensory deficits, and long-term disability. Early detection refers to identifying maternal infection prior to or during early gestation, or diagnosing fetal/neonatal infection promptly after exposure, enabling timely interventions (e.g., antiparasitic therapy for toxoplasmosis, penicillin for syphilis, delivery

planning for HSV). Early detection is linked to improved outcomes: for instance, early maternal treatment of toxoplasmosis can reduce intracranial lesions; first-trimester syphilis screening and treatment can prevent nearly all cases of congenital syphilis; timely identification of CMV influences counseling and monitoring, though definitive antiviral interventions remain under investigation. Despite recognized benefits, consensus on screening strategies varies: routine TORCH panel testing in low-risk asymptomatic pregnancies is debated, given prevalence differences and cost-effectiveness considerations. This review examines current evidence on the importance, methods, and outcomes of early detection of TORCH infections, aiming to inform clinical practice and guide future research.

METHODS

A narrative review methodology was employed. Databases searched included PubMed/MEDLINE, Google Scholar, and Embase. Organizational and guideline sources (e.g., WHO, CDC, professional society protocols, UpToDate summaries, hospital maternofetal protocols) were also consulted. Search terms combined "TORCH," "early detection," "prenatal screening," "serology," "PCR," "ultrasound," "amniocentesis," "neonatal diagnosis," and pathogen-specific terms (e.g., "congenital toxoplasmosis early diagnosis," "prenatal syphilis screening outcomes," "CMV prenatal detection," "HSV primary infection pregnancy"). The search period spanned January 2010 to May 2025. Inclusion criteria: original research (cohort studies, case-control, randomized trials where available), systematic reviews/meta-analyses, and guideline documents addressing timing or methods of detection and associated outcomes. Exclusion criteria: case reports lacking generalizable data on early detection impact, studies not addressing timing of diagnosis or outcomes post-detection, non-English publications. Titles and abstracts were screened; full texts of relevant articles were reviewed for data extraction. Data were categorized by pathogen, detection modality (maternal serology, imaging markers, molecular diagnostics), timing (preconception, first trimester, second/third trimester, neonatal period), subsequent interventions, and outcome measures (e.g., transmission rates, sequelae incidence). Where available, quantitative effect sizes (e.g., reduction in adverse outcomes with early detection/intervention) were recorded. Findings were synthesized qualitatively, and illustrative tables were created to summarize screening indications, methods, and outcome impacts.

RESULTS

Overview of Detection Modalities and Timing

Maternal Serology: IgM/IgG testing for specific TORCH pathogens is the cornerstone for identifying primary or recent maternal infection. First-trimester screening for rubella immunity is standard in many settings; syphilis serology (non-treponemal and treponemal tests) is universally recommended early in pregnancy. CMV and toxoplasmosis serology may be offered in high-prevalence or high-risk populations, though universal serological screening remains debated [1,2].

Molecular Diagnostics: PCR analysis of amniotic fluid (for CMV, toxoplasmosis) or maternal blood (where applicable) enhances specificity of fetal infection diagnosis; optimal timing (e.g., amniocentesis after 21 weeks and at least 6–8 weeks post-maternal infection for toxoplasmosis) is critical to reduce false negatives.

Ultrasound Markers: Serial ultrasound may detect fetal anomalies suggestive of congenital infection (e.g., intracranial calcifications in toxoplasmosis or CMV, hydrops in parvovirus B19, cardiac defects in rubella). However, imaging findings often appear after the window for optimal intervention has narrowed; thus, reliance on ultrasound alone may delay detection.

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Neonatal Screening: For infants at risk (e.g., maternal primary infection near term), neonatal testing (PCR on saliva/urine for CMV, direct culture or PCR for HSV, serology for syphilis) enables early management but cannot prevent in utero injury; still, early detection facilitates prompt treatment to mitigate sequelae (e.g., antiviral therapy for congenital CMV-associated hearing loss surveillance).

Pathogen-Specific Early Detection and Outcomes

Toxoplasma gondii

Detection: Maternal seroconversion monitoring: serial IgG/IgM tests in seronegative women; avidity testing refines timing. Amniotic fluid PCR after appropriate gestational interval confirms fetal infection. Ultrasound may detect severe manifestations but appears later.

Outcomes: Studies show that early maternal detection (ideally in first trimester) followed by prompt antiparasitic therapy (e.g., spiramycin, pyrimethamine-sulfadiazine with folinic acid) reduces risk and severity of fetal sequelae (e.g., intracranial lesions, chorioretinitis) compared to delayed detection. Quantitatively, treated cases identified early demonstrate lower rates of severe outcomes by up to 50–60% versus untreated or late-detected cases.

Rubella Virus

Detection: Preconception or early pregnancy serology to confirm immunity; non-immune women counseled preconception. If maternal infection occurs, IgM detection and PCR on amniotic fluid may confirm fetal infection.

Outcomes: Given absence of specific antiviral therapy, early detection primarily serves counseling (consideration of pregnancy continuation) and neonatal planning. Early identification of non-immune status allows preconception vaccination to prevent infection. Regions with high vaccination coverage see minimal congenital rubella; where rubella infection occurs early in pregnancy, outcomes are generally severe and irreversible, underscoring prevention rather than treatment.

Cytomegalovirus (CMV)

Detection: Maternal serology to identify primary infection (seroconversion). Amniotic fluid PCR at ≥21 weeks, ≥6–8 weeks after suspected infection, confirms fetal infection. Ultrasound may detect abnormalities (ventriculomegaly, calcifications) later in gestation. Neonatal PCR screening (saliva/urine) identifies asymptomatic infected infants for monitoring.

Outcomes: Early detection allows close monitoring (e.g., serial ultrasound for brain abnormalities), consideration of experimental interventions (e.g., maternal CMV hyperimmune globulin—efficacy inconclusive), and preparation for neonatal management. Early neonatal detection facilitates audiologic monitoring and early intervention for hearing loss or developmental support. Although specific in utero treatments are limited, awareness enables families and clinicians to plan and potentially enroll in trials.

Herpes Simplex Virus (HSV)

Detection: Maternal primary infection detection via serology and clinical history; however, serology may not distinguish timing reliably. Antepartum identification of primary infection in late pregnancy is valuable.

Outcomes: Early detection of primary maternal HSV near term informs delivery planning: elective cesarean reduces neonatal transmission risk. Antiviral prophylaxis starting at 36 weeks in women with recurrent HSV reduces symptomatic lesions at delivery; early detection of primary infection supports more intensive management. Neonatal early detection (PCR on lesions or CSF) allows prompt acyclovir therapy, reducing morbidity/mortality.

Syphilis

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Detection: Universal early pregnancy screening with non-treponemal (e.g., RPR) and confirmatory treponemal tests. Repeat screening in third trimester or at delivery in high-prevalence or high-risk settings.
Outcomes: Early treatment with penicillin (ideally before 28 weeks) virtually eliminates congenital syphilis; late detection associated with stillbirth, neonatal death, or lifelong sequelae. Studies demonstrate an >80–90% reduction in adverse outcomes when screening and treatment occur early in pregnancy.

Other Agents (Varicella, Parvovirus B19, etc.)

Detection: Serology for preconception immunity (varicella); if maternal exposure occurs, timely testing shapes prophylaxis (varicella-zoster immune globulin) or monitoring (for parvovirus: fetal hydrops surveillance).
Outcomes: Early recognition of susceptibility allows prevention; if infection occurs, early fetal monitoring (e.g., middle cerebral artery Doppler for hydrops) can guide intrauterine transfusion decisions, improving outcomes in parvovirus B19 infection.

Screening Strategies: Universal vs. Targeted

Universal TORCH Panel Screening: In low-risk asymptomatic pregnancies, routine full TORCH panel screening is generally not recommended due to low positive predictive value and cost concerns, especially where prevalence of certain infections is low. However, some regions with high prevalence (e.g., toxoplasmosis, CMV) may consider offering serology to identify primary infections.
Targeted Screening: Indications include maternal symptoms or rash suggestive of infection, known exposure events, abnormal ultrasound findings (e.g., fetal growth restriction, intracranial anomalies, hydrops), or high-risk behaviors/environments. Targeted screening improves diagnostic yield and cost-effectiveness.
Timing: First prenatal visit for baseline serology (rubella immunity, syphilis screening universally). Subsequent testing as indicated by new exposures or ultrasound findings. In suspected acute infections, timing of tests must consider window periods and appropriate intervals for confirmatory testing (e.g., toxoplasmosis avidity testing, CMV seroconversion interval).

Table 1. Screening Indications, Modalities, and Timing for TORCH Pathogens

Pathogen	Screening Indication	Modality	Optimal Timing	Notes
Toxoplasma gondii	Seronegative women in high-prevalence areas; ultrasound anomalies; known exposure	Maternal IgG/IgM + avidity; amniotic fluid PCR	Serology early pregnancy; PCR ≥21 weeks & ≥6–8 weeks post-infection	Early treatment reduces sequelae
Rubella	Women of childbearing age (preconception); early pregnancy immunity check	Maternal IgG/IgM	Preconception; first trimester	Vaccination preconception most effective
CMV	Suspected primary	Maternal IgG/IgM	Maternal serology	No licensed

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	infection; ultrasound anomalies; high-risk exposures	seroconversion; amniotic fluid PCR; neonatal PCR	early if exposure; PCR ≥21 weeks post-infection	vaccine; monitoring focus
HSV	History of genital lesions; suspected primary infection near term	Clinical exam; serology (limited timing value); neonatal PCR	Late pregnancy detection critical for delivery planning	Antiviral prophylaxis from 36 weeks
Syphilis	Universal early pregnancy screening; high-risk behaviors; repeat in high-prevalence areas	Non-treponemal + treponemal tests	First prenatal visit; repeat as indicated	Penicillin treatment before 28 weeks key
Varicella	Preconception susceptibility; exposure during pregnancy	Maternal IgG; PCR if acute infection; varicella-zoster IG	Preconception; upon exposure during pregnancy	Vaccinate preconception; IG for post-exposure prophylaxis
Parvovirus B19	Exposure in high-contact settings (childcare); ultrasound anomalies	Maternal IgG/IgM; fetal MCA Doppler	Upon exposure; fetal monitoring from 16–24 weeks if infection	Intrauterine transfusion if hydrops

Table 2. Impact of Early Detection and Intervention on Outcomes

Pathogen	**Early Detection Scenario**	**Intervention**	**Reported Outcome Improvement**
Toxoplasma gondii	Maternal seroconversion identified in first trimester	Spiramycin → pyrimethamine regimen	Reduction in severe intracranial lesions by ~50–60%; improved neurodevelopmental outcomes
Rubella	Preconception immunity confirmed; non-immune women vaccinated	Vaccination preconception	Near-elimination of CRS in vaccinated populations
CMV	Primary maternal infection detected early; amniotic fluid PCR confirms fetal infection	Serial ultrasound monitoring; potential enrollment in trials (e.g., hyperimmune globulin)	Early counseling; neonatal monitoring for hearing loss; trial data mixed on intervention efficacy
HSV	Primary infection near term identified	Antiviral prophylaxis; cesarean delivery if active lesions	Reduction in neonatal HSV transmission rates by ~50–70%

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Syphilis	Positive serology at first prenatal visit	Penicillin therapy before 28 weeks	>80–90% reduction in congenital syphilis and related adverse outcomes
Varicella	Susceptible woman vaccinated preconception; exposure identified early	Vaccination preconception; varicella-zoster IG post-exposure	Prevention of maternal infection; reduced fetal varicella complications
Parvovirus B19	Exposure in pregnancy identified early	Fetal monitoring; intrauterine transfusion if hydrops	Improved survival in hydrops cases; reduced fetal loss with timely transfusion

DISCUSSION

The evidence underscores that early detection of TORCH infections substantially influences management decisions and can reduce adverse outcomes. For pathogens with effective interventions (e.g., syphilis, toxoplasmosis), early maternal detection and treatment are directly linked to lowered risk of fetal infection or reduced severity of disease. Rubella prevention relies predominantly on preconception detection of immunity; early serology avoids primary infection during pregnancy. CMV remains challenging: while early detection informs monitoring and potential trial enrollment, definitive in utero treatments are not yet standardized, highlighting need for continued research into antiviral or immunoglobulin therapies. However, early neonatal detection post-delivery ensures timely audiological and developmental follow-up, partially mitigating long-term sequelae. HSV management benefits from late-pregnancy detection guiding prophylaxis and delivery mode decisions to reduce neonatal transmission.

Screening strategy debates reflect balancing diagnostic yield, cost-effectiveness, and prevalence: universal TORCH panel testing in low-risk asymptomatic women may yield low positive predictive value, unnecessary anxiety, and resource burden; targeted screening based on risk factors, exposures, or ultrasound findings maximizes efficiency. Optimal protocols integrate baseline serology for universally screened pathogens (rubella, syphilis), with selective testing for others when indicated. Molecular diagnostics have enhanced specificity for fetal infection confirmation but require precise timing to avoid false negatives; this necessitates clinician awareness of test windows. Ultrasound remains valuable for identifying fetal anomalies suggestive of infection but often appears after the window for optimal intervention—thus reinforcing the importance of earlier serological or molecular detection.

Barriers to early detection include asymptomatic maternal infections, limited access to timely prenatal care or diagnostic tools in low-resource settings, variability in provider awareness, and absence of licensed vaccines or definitive treatments for certain TORCH pathogens (e.g., CMV, toxoplasmosis). Strengthening antenatal care systems, ensuring timely first-trimester visits, and providing education on exposure risks can facilitate earlier detection. Development and validation of novel biomarkers or point-of-care tests could enable broader early screening, especially in resource-limited contexts. Additionally, establishing standardized algorithms for managing detected infections—including referral pathways, counseling, and, where available, treatment protocols—is essential to translate early diagnosis into improved outcomes.

Future research priorities include: (1) large-scale cost-effectiveness analyses comparing universal versus targeted screening in varied epidemiological settings; (2) trials of potential in utero therapies for CMV and toxoplasmosis; (3) development of vaccines (e.g., CMV vaccine) to

enable true primary prevention; (4) evaluation of rapid, low-cost diagnostic platforms suitable for low- and middle-income countries; (5) implementation research on integrating TORCH detection into routine maternal health services and monitoring resultant impact on neonatal outcomes.

CONCLUSION

Early detection of TORCH infections is pivotal for optimizing maternal–fetal health, enabling timely interventions, informed counseling, and planning to mitigate adverse outcomes. For pathogens amenable to treatment (e.g., syphilis, toxoplasmosis), early maternal diagnosis and therapy markedly reduce fetal infection risk or severity. For others (e.g., CMV, rubella), early detection informs monitoring, preventive counseling, and neonatal management. Targeted screening—guided by prevalence, risk factors, and ultrasound findings—offers a cost-effective approach, while universal baseline serology for key pathogens remains standard. Enhanced diagnostic modalities, robust antenatal care frameworks, and ongoing research into vaccines and therapies are needed to further advance the benefits of early detection. Integration of evidence-based algorithms into routine prenatal and neonatal care can significantly reduce the burden of TORCH-related morbidity and mortality.

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