

American Pediatric Surgical Association

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**Prenatal Counseling Series**

**Twin-Twin Transfusion Syndrome**



**APSA**  
American Pediatric  
Surgical Association  
*Saving Lifetimes™*

from the  
**Fetal Diagnosis and Treatment Committee**

of the  
American Pediatric Surgical Association

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Special thanks to Niti Shahi, MD, Nicholas Behrendt, MD,  
and Jill Stein, MD

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## Twin-Twin Transfusion Syndrome

### Definition

TTTS: shift of intravascular volume between twins with a shared placenta

### Etiology and Background

- **Mainly** diagnosed in **monochorionic** (1 placenta), **diamniotic** (2 amniotic sacs) gestations who share a **common placenta**
- The donor and recipient twins also share multiple **vascular connections/anastomoses** (1)
  - Vascular anastomoses include artery-to-artery connections (**AA**), vein-to-vein connections (**VV**), and veno-arterial connections (**VA**)
- Progression of disease: Unbalanced blood flow in vascular anastomoses in the shared placenta resulting in unequal volume balances between both fetuses → hypervolemia in recipient twin and hypovolemia in donor twin → increased mortality risk, organ failure, cardiac complications and neurodevelopmental impairment (1)
- Incidence: **10-15%** of monochorionic twins (2)
  - If untreated, TTTS can result in 90% mortality of one or both twins (2)
- Donor versus recipient twin:



**Figure 1.** Schematic of Twin-Twin Transfusion Syndrome.

*Courtesy of the Colorado Fetal Care Center.*

	Donor Twin	Recipient Twin
<b>Mechanism</b>	Volume shunted away from donor twin → persistent <b>hypovolemia</b> → <b>oligohydramnios</b>	Volume shunted to recipient twin → persistent <b>hypervolemia</b> → <b>polyhydramnios</b>
<b>US findings</b>	<b>Oligohydramnios</b> , absent bladder, abnormal Doppler blood flow	<b>Polyhydramnios</b> , large bladder
<b>Complications</b>	IUGR, hydrops, death (1) Increased mortality rate in <b>donor twin</b> (3)	<b>hydrops</b> (pleural effusions, ascites, skin edema, & pericardial effusions), high output CHF, death

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Figure 2

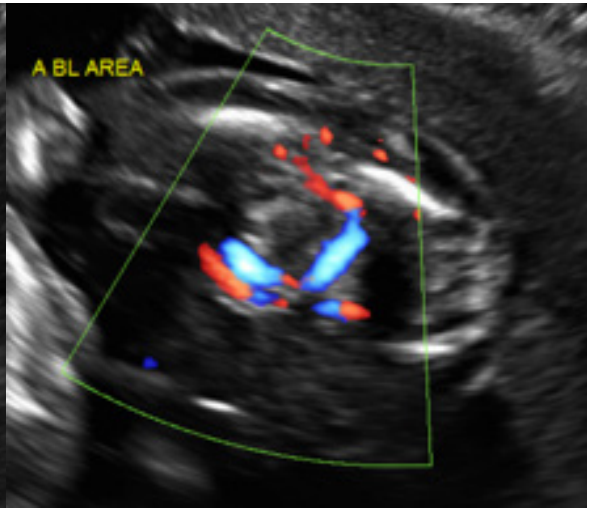


Figure 3



Figure 4

**Figure 2:** Transverse grayscale ultrasound image of the fetal pelvis in a donor twin shows lack of fluid within the urinary bladder.

**Figure 3:** Transverse color Doppler ultrasound image of the the fetal pelvis in the same donor twin shows lack of fluid within the urinary bladder with expected location between the umbilical arteries.

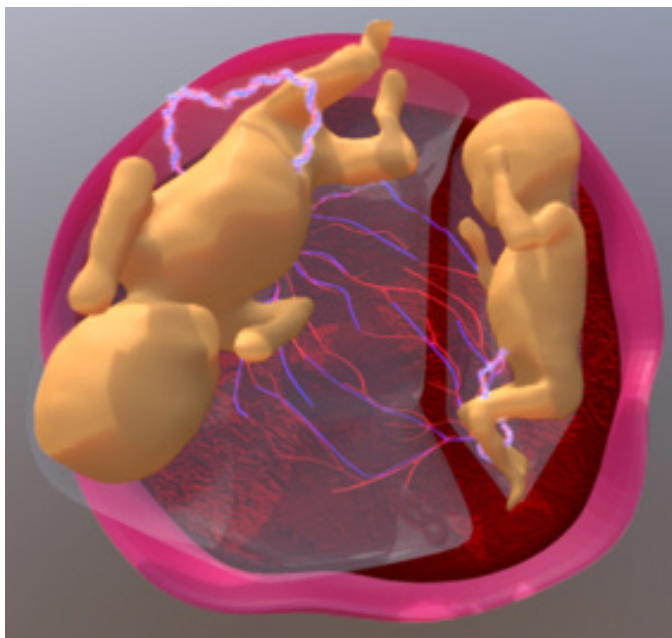
**Figure 4:** Longitudinal ultrasound of a donor twin demonstrates lack of fluid within the urinary bladder.

*Courtesy of Jill Stein, MD - Colorado Fetal Care Center*

- Associated anomalies:
  - IUGR in 20% of cases (2)
  - Chromosomal abnormalities (4)
  - Congenital cardiac defects (5-10)
  - Cerebral lesions (5-10)
- Worse prognosis with the following:
  - More severe presentation when it manifests **<20 weeks** (1, 11)
  - **Higher Quintero** stage
  - Fetal growth **discordance >30%** (3, 10), IUGR in one or both fetuses

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**Figure 5.** 3-Dimensional Anatomical model of Twin-twin Transfusion Syndrome.

*Courtesy of Christine Castillo, Nicholas Behrendt, MD and Rony Marwan, MD, Colorado Fetal Care Center*

## Differential Diagnosis (2)

- 1) IUGR (selective intrauterine growth restriction)
- 2) TAPS (twin anemia polycythemia sequence)
- 3) Discordant twins secondary to anomaly
- 4) Subjective fluid discordance
- 5) Dichorionic twin gestation with fluid discordance
- 6) Discordant twins secondary to infection

## Prenatal Consideration

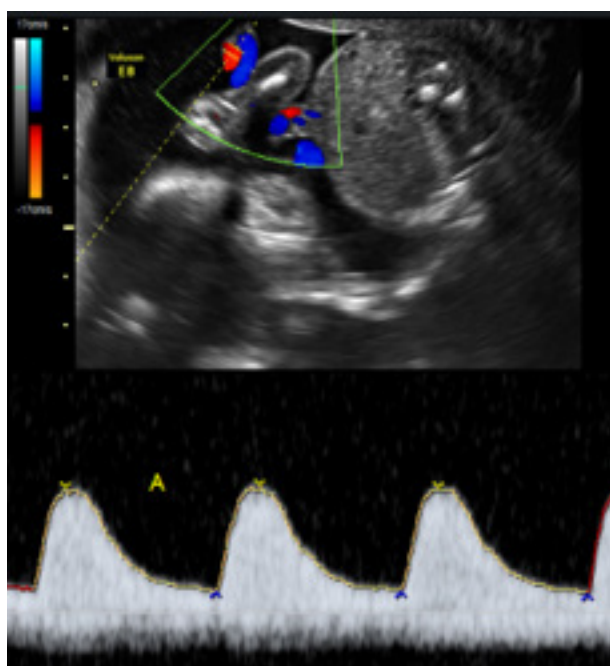
- **Monoamniotic Dichorionic twin monitoring: (2)**
  - 1st trimester ultrasound assessment: chorionicity, nuchal translucency
  - Starting at 16 weeks, q2 week surveillance with ultrasound: **amniotic fluid evaluation**, middle cerebral artery (**MCA**) **peak systolic velocity** (increased frequency if abnormal)
  - If patient is diagnosed with TTTS, recommend **echocardiogram**
  - Monthly fetal growth evaluations

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**Diagnosis**

- Based on current ultrasound surveillance and **echocardiography**
- **Current staging systems:** (12)
  - Quintero staging for TTTS: (2, 4, 11)
  - Cincinnati modification of the Quintero staging: incorporates echo findings of AV valve function, ventricular hypertrophy and ventricular function (13)
  - CHOP cardiovascular score in TTTS (14-17)
  - Cardiovascular Profile Score (CVPS) for fetal hydrops (18)

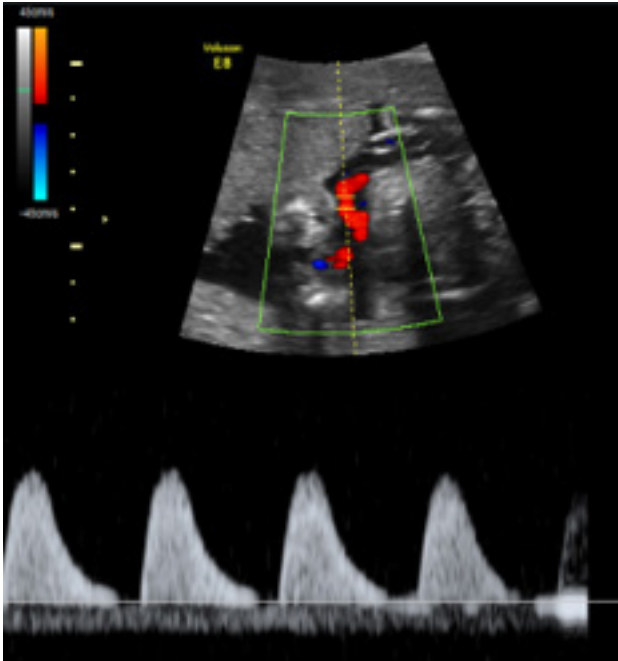
Quintero Staging for TTTS	
<b>Stage 1</b>	Polyhydramnios, oligohydramnios, bladder of donor visible
<b>Stage 2</b>	Dopplers are not critically abnormal, bladder is not visualized in donor twin
<b>Stage 3</b>	Abnormal Doppler studies in donor or recipient twin (i.e. absent or reversal umbilical artery end diastolic flow, reversal of ductus venosus a-wave, and/or pulsatile umbilical vein flow)
<b>Stage 4</b>	Hydrops of one or both twins
<b>Stage 5</b>	Death of one or both twins



**Figure 6.** Normal umbilical arterial spectral Doppler waveform pattern in a donor twin with brisk systolic upstroke and positive diastolic flow.

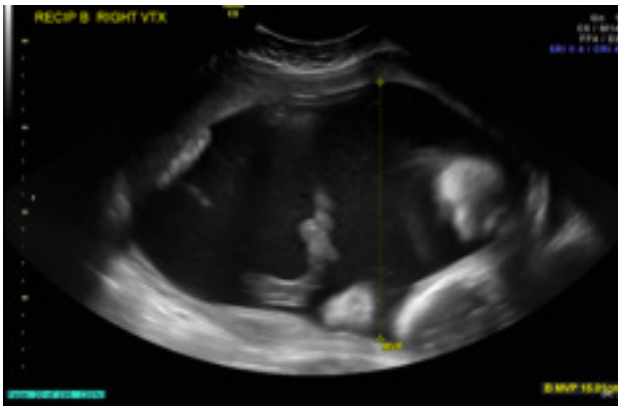
*Courtesy of Jill Stein, MD - Colorado Fetal Care Center*

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**Figure 7.** Abnormal umbilical arterial spectral Doppler waveform pattern in a recipient twin with absent diastolic flow.

*Courtesy of Jill Stein, MD - Colorado Fetal Care Center*



**Figure 8.** Demonstration of polyhydramnios in Recipient twin on Ultrasound.







*Courtesy of Nicholas Behrendt, MD - Colorado Fetal Care Center*

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Cardiomyopathy			
Variable	Mild (Stage 3a)	Moderate (Stage 3b)	Severe (Stage 3c)
AV regurgitation	Mild	Moderate	Severe
RV/LV thickness	Mild	Moderate	Severe
MPI (myocardial performance index)	>2+ Z-score	≥ +3 Z-score	≥ +4 Z-score
LV-MPI	> 0.43 to 0.48	≥ +4 Z-score	≥ 0.53
RV-MPI	> 0.48 to 0.56	> 0.56 to 0.64	≥ 0.64

CHOP Cardiovascular Score- Recipient Twin					
	Score	0	1	2	3
<b>Ventricular characteristics</b>	Cardiac enlargement	None	Mild	Moderate-Severe	
	Ventricular hypertrophy	None	Mild	Moderate-Severe	
	Systolic dysfunction	None	Mild	Moderate-Severe	
<b>Valve function</b>	Tricuspid regurgitation	None	Mild	Moderate-Severe	
	Mitral regurgitation	None	Mild	Moderate-Severe	
<b>Venous Doppler Characteristics</b>	Tricuspid valve inflow	2 peaks	1 peak		
	Mitral valve inflow	2 peaks	1 peak		
	Ductus venosus	Forward	Decreased atrial contraction	Reversal of flow	
	Umbilical vein pulsation	None	+		
<b>Great Vessel Analysis</b>	Outflow tracts	PA>Aorta	PA= aorta	PA<Aorta	RV outflow obstruction
	Pulmonary insufficiency	None	+		
<b>Arterial Doppler Characteristics</b>		Normal	Decreased diastolic flow	No flow or reversal of diastolic flow	

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Fetal Cardiovascular Profile Score			
	2	1	0
Hydrops	None	Ascites, pleural effusion or pericardial effusion	Skin edema
Cardiomegaly (cardiac area/thoracic area)	>0.2 to 0.35	0.35 to 0.50	<0.2 OR >0.5
Cardiac function	Normal, diastolic filling	Holosystolic TR	Holosystolic MR, monophasic diastolic filling
Arterial umbilical Doppler			
Venous Doppler (umbilical vein and ductus venosus)			

**Treatment**

**1) Amnioreduction**

- a. Definition: removal of excess amniotic fluid from **recipient** twin, can be done serially
- b. Usually not a curative procedure, potential for persistence/recurrence (19-21)
- c. Frequently used if twins **>26 weeks** gestation (1)
- d. Indication: often for non-complicated TTTS, potentially reverses TTTS in early Quintero stages
- e. Advantages: decreases the side effects of polyhydramnios in recipient twin, may be therapeutic
- f. Risks: **worsening of TTTS**, risk of bleeding, chorioamniotic membrane separation, premature rupture of membranes (PROM)→ prematurity, fetal loss, neurologic impairment, septostomy (rupture of amniotic membrane increased need for additional procedures), uterine bleeding, chorioamnionitis, etc. (1, 2)

**2) Septostomy**

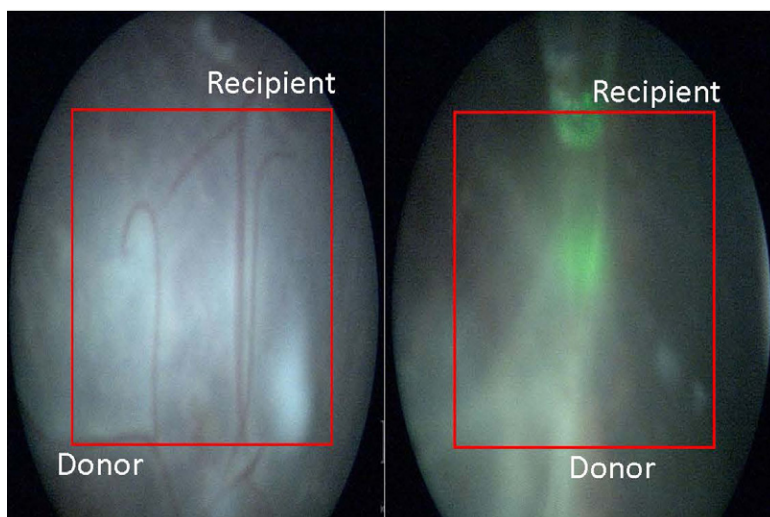
- a. Definition: deliberate puncture into the intertwin membrane to allow for equilibration of amniotic fluid volumes (21, 22)
- b. Risks: cord entanglement, fetal loss



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- 3) **Ultrasound or fetoscopic-guided radio frequency ablation (selective fetal reductions)**
  - a. Definition: selective radiofrequency ablation of the cord of the diseased co-twin or co-twin with significant anomaly in effort to improve the survival of the other twin
  - b. Risks: neurologic injury of surviving twin, PPROM (21)
- 4) **Fetoscopic coagulation of vascular anastomoses (laser ablation)**
  - a. Considered **standard of care** (3), improved survival over amnioreduction
  - b. Indication: Advanced Quintero stages, frequently during **16-26 weeks** of gestation
  - c. Methods: (24-27)
    - i. **Non-selective:** Coagulation of all placental vessels that cross the intertwin membrane/membranous equator, decreased donor survival
    - ii. **Selective:** Coagulation of selective connections
    - iii. **Sequential:** The order of ablation is as follows: donor artery-recipient vein anastomosis, recipient artery-donor vein anastomosis, V-A, and lastly A-A.
    - iv. **Solomon method:** Planned laser ablation between vascular connections along the vascular equator; decreased recurrence of TTTS and TAPS (24)
  - d. Amnioreduction frequently performed at the end of the procedure
  - e. Advantages: increased survival of both twins, decreased neurologic morbidities (2)
  - f. Risks: PROM, premature delivery, chorionic membrane septation, treatment failure (may miss vascular anastomoses), and fetal demise (2, 3)
  - g. Contraindication: PPROM (1)



**Figure 9.** Before and after Fetoscopic Coagulation of Vascular anastomose.

*Courtesy of Nicholas Behrendt, MD - Colorado Fetal Care Center*

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#### Postnatal Considerations

- Average gestational age at delivery **31-32 weeks** (28)
- After fetoscopic photo coagulation, recommend weekly ultrasound surveillance and Doppler studies, particularly for recurrent TTTS and TAPS (1)
- **Complications:** (2)
  - Twin anemia polycythemia sequence (**TAPS**)
  - Selective fetal intrauterine growth restriction (**sIUGR**)
  - **Recurrent TTTS**
  - **Fetal demise**
    - Rate of co-twin demise 12-25% (14)
    - Higher risk of death in **donor twin**
  - Neurologic injuries and/or **neurodevelopment impairment** including cerebral palsy, quadriplegia/diplegia/hemiplegia, developmental delay, blindness and hearing impairment (5)
    - Higher risk of neurodevelopment impairment with advanced gestational age at time of laser therapy, high Quintero stage, low gestational age at birth and low birth weight (limitation: only teen mother population) in both donor and recipient twins (no difference between donor and recipients) (28)
  - **Prematurity and associated complications**
  - **Cardiac complications** from volume overload such as ventricular hypertrophy, ventricular dysfunction, valvular defects and heart failure (6, 17, 29, 30)
  - **Respiratory complications**
  - **Renal failure**

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