Quick Reference Guide to Results from Massachusetts Newborn Screening for Hemoglobinopathies [1]

NB Screen Result [2]	Description [3]	Genotype	Start Penicillin	Testing and Referral [4]
FA	Normal	**AA**	No	None
FS	Sickle Cell Anemia OR Sickle-ß^0 Thalassemia OR Sickle with Hereditary Persistence of Fetal Hemoglobin	**SS** **S-ß^0 Thalassemia** **S-HPFH**	**Yes**	Hematology referral [5] Family testing and counseling
FSC	Sickle-C Disease	**SC**	**Yes**	Hematology referral Family testing and counseling
FSA	Sickle ß$^+$ Thalassemia	**SA**	**Yes**	Hematology referral Family testing and counseling
FSV [6]	Sickle with Hemoglobin Variant	**SV**	**Yes**	Hematology referral Family testing and counseling
FSE/O or FSD/G	Sickle with indeterminate hemoglobin pattern; both indeterminate patterns indicate increased risk for sickling disorder	**Multiple possibilities**	**Yes**	Hematology referral Family testing and counseling
FC	Hemoglobin C Disease OR Hemoglobin C-ß^0 Thalassemia	**CC** **C-ß^0 Thalassemia**	No	Hematology referral Family testing and counseling
FE/O [7]	Multiple possibilities of E, O and ß^0 Thalassemia	**Multiple possibilities**	No	Family testing and counseling Contact hematology with results of family testing
F ***(fetal Hb only)***	Hereditary Persistence of Fetal Hemoglobin OR ß Thalassemia Major (age dependent) Premature Infant	**Multiple possibilities**	No	Hematology referral if no HbA on repeat newborn screen at adjusted gestational age 40 weeks [8]
FAS	Sickle Cell Trait (carrier)	**AS**	No	Family testing and counseling
FAC	Hemoglobin C Trait (carrier)	**AC**	No	Family testing and counseling
FAV **FAO/E** **FAD/G**	Carrier of Hemoglobin Variant including E, O, G or G	**AV** **A with either E, O, D or G trait**	No	Confirmatory testing [9] Contact hematology if needed Family testing and counseling
FAB	Presence of Hemoglobin Bart's [10]	**AA**	No	α thalassemia of unknown severity See Hb Bart's flowsheet
****T**	Pattern suggests transfusion	**Multiple possibilities**	No	If not transfused repeat test If transfused repeat test 2 months after last transfusion

[1] Population-based newborn screening is not meant to replace appropriate diagnostic workup. Clinical concern for hemoglobinopathy should prompt referral to hematology regardless of NBS result.
[2] Hemoglobin traits are listed in order of predominance. For example, FAS means F>A>S (sickle trait) while FSA means F>S>A (sickle ß$^+$ thal disease). Therefore FAS does not equal FSA.
[3] Additional detailed information for any result other than FA is available on the fact sheets provided by the Newborn Screening Program (617-983-6300).
[4] Any result that indicates a potential disease needs to be confirmed with a second filter paper sample sent to the Newborn Screening Program. Family testing requires a CBC and Hb electrophoresis from the biological parents.
[5] The distinction between HbSS and S-ß^0 Thalassemia requires evaluation of electrophoresis results, CBC, red cell morphology, iron stores and parent testing. The hematologist will determine the true genotype. This distinction is necessary for genetic counseling, but does not affect clinical management.
[6] Certain hemoglobin variants ("V") in combination with HbS may be as severe as HbSS. HbS with any hemoglobin other than HbA (HbAS) may produce a clinically significant condition requiring specialized care and should be referred to hematology for further evaluation. Hemoglobin variants may require further testing by a reference laboratory to identify and diagnose. These variants include the results FSE/O and FSD/G. In Massachusetts, the report of newborn screening results does not make a distinction between HbE from HbO (E/O) or HbD from HbG (D/G); therefore, referral to hematology recommended.
[7] In Massachusetts, the report of newborn screening results does not make a distinction between hemoglobins HbE from HbO (E/O) or HbD from HbG (D/G). With this result, perform biological parent testing (CBC and Hb electrophoresis) and contact hematologist with results to determine if referral is necessary. HbEE is a benign condition and requires only family testing and counseling; whereas HbE-ß^0 Thalassemia is clinically significant condition and requires specialized care.
[8] If premature infant, retest when adjusted gestational age is 40 weeks and 2 months after last transfusion.
[9] Some hemoglobin patterns may require further testing by a reference laboratory to identify and diagnose. Follow-up testing to identify specific hemoglobins is necessary for effective genetic counseling.
[10] Presence of Hb Bart's with any newborn screen result indicates the presence of α thalassemia of unknown severity. See Hb Bart's flowsheet.

Quick Reference Guide for Hemoglobin Testing Interpretation for the Patient Age Greater than Six Months (>6 months)

Description	Genotype[11]	HbA %	Hb Other[12] %	Testing and Referral[13]
Normal	**AA**	95-98	-----	None
Sickle Cell Anemia	**SS**	0	S 75-95	Hematology referral[14] Family testing and counseling
Sickle- **ß**^{0}Thalassemia	**S-ßThal**^{0}	0	S 80-95	Hematology referral Family testing and counseling
Sickle -C Disease	**SC**	0	S 45-50 C 45-50	Hematology referral Family testing and counseling
Sickle -**ß** $^{+}$ Thalassemia	**S-ßThal**$^{+}$	5-30	S 65-90	Hematology referral Family testing and counseling
Sickle with Hemoglobin Variant[15]	**SV**	0	S 40-60 V 40-60	Hematology referral Family testing and counseling
Hemoglobin C Disease OR Hemoglobin C- **ß** ^{0} Thalassemia	**CC** **C-ß^{0}Thal**	0	C >50	Hematology referral Family testing and counseling
Hemoglobin E Disease OR Hemoglobin E- **ß** ^{0} Thalassemia	**EE** **E-ß^{0}Thal**	0	E 80-90	Contact hematology[16] Family testing and counseling
Sickle Cell Trait	**AS**	50-60	S 35-45	Family testing and counseling
Hemoglobin C Trait	**AC**	50-60	C 50	Family testing and counseling
Hemoglobin Variant Trait	**AV**	40-60	V 40-60	Confirmatory testing[17] Contact hematology if necessary Family testing and counseling

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[11] Hemoglobin results are listed in order of predominance. In other words, AS means A>S (trait) and that SA means S>A (disease). Therefore FAS does not equal FSA.

[12] In general, HbA_2 >3.5 indicates ß-thal trait. However, in the presence of HbS, HbA_2 is falsely elevated; the usual range is 3-6%. This includes patients with sickle cell trait (HbAS) and any sickling disorder. Thus HbA_2 >3.5 in any patient with the presence of HbS (sickle cell trait or a sickling disorder) does not necessarily indicate ß-thal trait. HbF is normally <1%. It may be elevated in the sickling disorders,

[13] Family testing requires a CBC and Hb electrophoresis from the biological parents.

[14] The distinction between HbSS and S-ß^{0} Thalassemia requires evaluation of electrophoresis results, CBC, red cell morphology, iron stores and parent testing. The hematologist will determine the true genotype. This distinction is necessary for genetic counseling, but does not affect clinical management.

[15] HbS with any trait other than HbA (HbAS) may be a clinically significant condition requiring specialized care and should be referred to hematology for further evaluation. Certain combinations may be as severe as Hb SS. Variant hemoglobins may require further testing by a reference laboratory to diagnose.

[16] For any patient with HbE without HbA, consult a hematologist with lab results (CBC and Hb electrophoresis) to determine genotype and need for referral. Hemoglobin EE is a benign condition and requires only family testing and counseling. Patients with HbE-ß ^{0} thalassemia have a clinically significant condition that requires hematology referral and specialized care.

[17] Variant hemoglobins may require further testing by a reference laboratory to diagnose. This information is necessary for genetic counseling.

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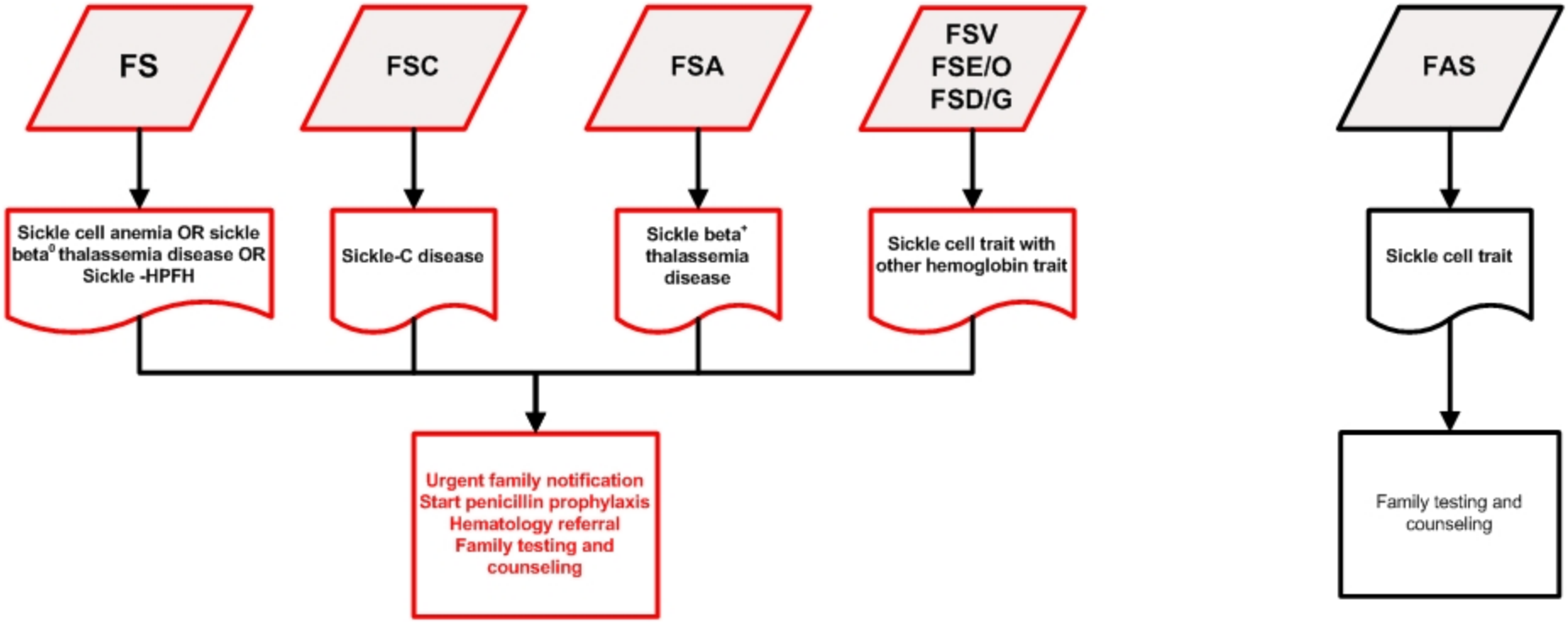
Quick Reference Guide for Initial Evaluation Using Results from Massachusetts Newborn Screening for Hemoglobinopathies



NOTES

- Population-based newborn screening is not meant to replace appropriate diagnostic workup. Clinical concern for hemoglobinopathy should prompt referral to hematology regardless of Newborn Screen result.
- Newborn Screen results list hemoglobins in order of predominance. For example, FAS means F>A>S (sickle trait) while FSA means F>S>A (sickle ß$^+$ thal disease). Therefore FAS does not equal FSA.
- Additional detailed information for any result other than FA is available on the fact sheets provided by the Newborn Screening Program (617-983-6300).
- Any result that indicates a potential disease needs to be confirmed with a second filter paper sample sent to the Newborn Screening Program. Family testing requires a CBC and Hb electrophoresis from the biological parents.
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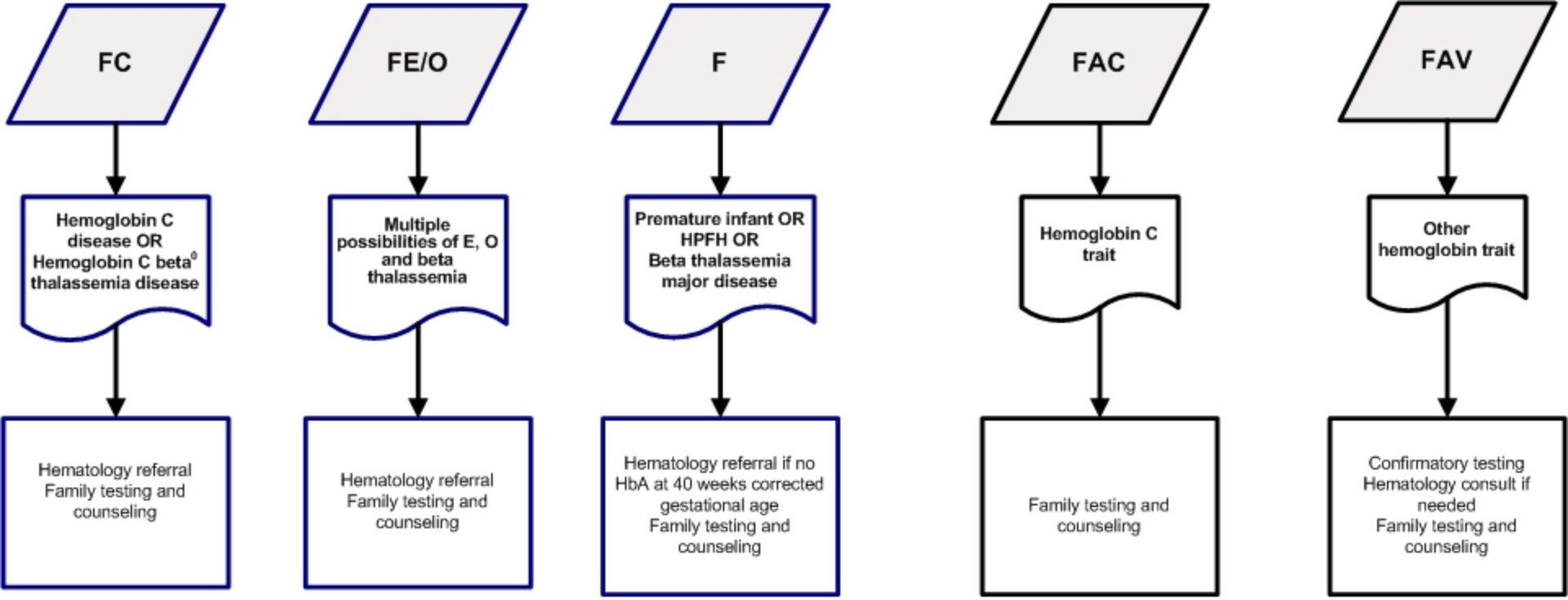

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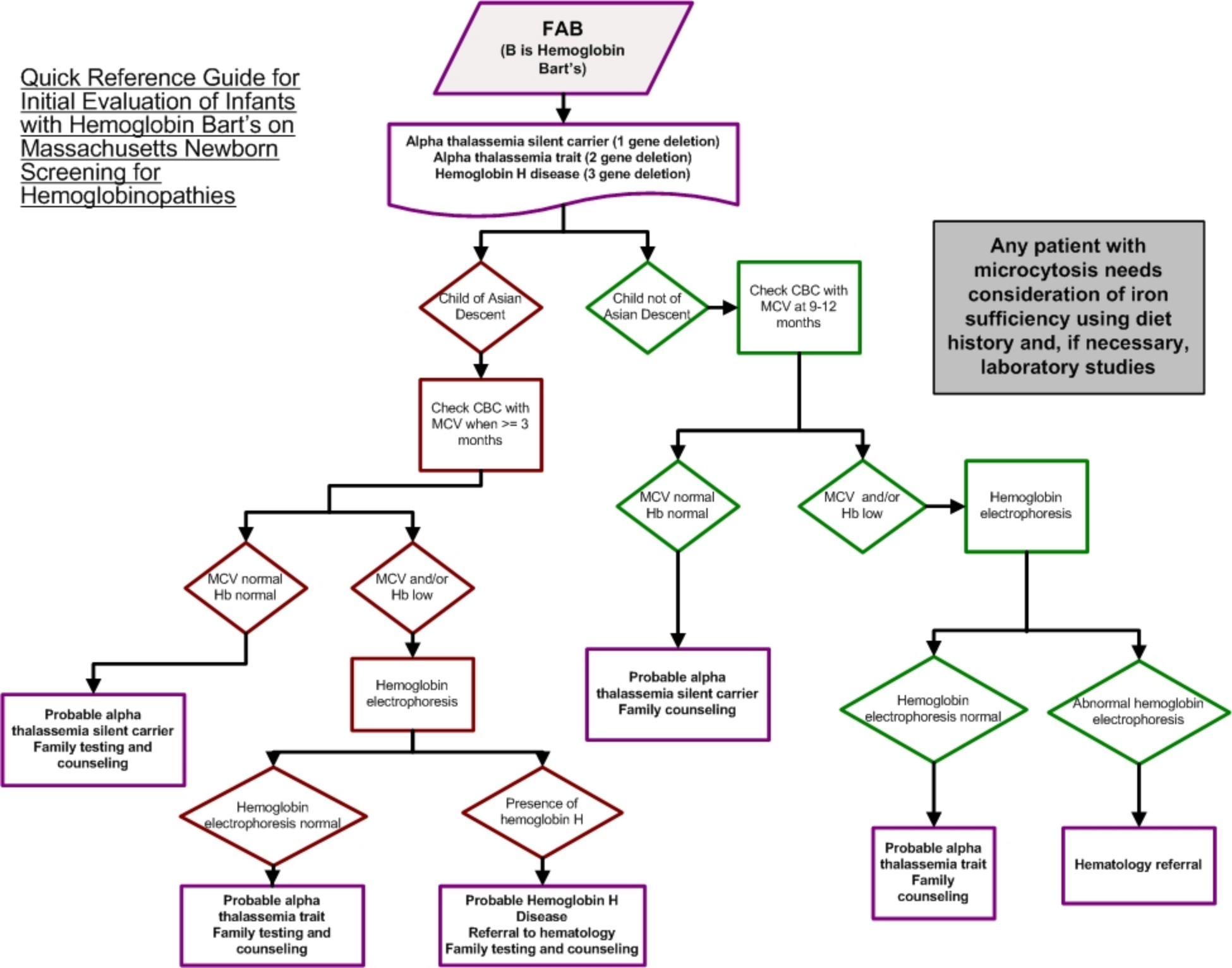
Quick Reference Guide for Initial Evaluation of Infants with Hemoglobin Bart's on Massachusetts Newborn Screening for Hemoglobinopathies



Pediatric Hematology Contact Information

Baystate Medical Center
Springfield, MA
413/794-9338

Boston Floating Hospital for Children
Boston, MA
617/636-5535

Boston Medical Center
Boston, MA
617/414-5725

The Children's Hospital Boston
Boston, MA
617/355-8246

Massachusetts General Hospital
Boston, MA
617/726-2737

UMass Memorial Medical Center
Worcester, MA
508/856-4225

New England Newborn Screening Program
617/983-6300

NEPSCC
New England Pediatric Sickle Cell Consortium

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