# Small study affirms accuracy of free mobile app that screens for liver disease in newborns

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In a small study, researchers from the Johns Hopkins Children's Center report they have verified the ability of a free smartphone app to accurately read, interpret and record the color of a newborn's poop as a possible early symptom of biliary atresia (BA)—a rare disorder that accounts for nearly half of pediatric end-stage liver disease in the United States.

For the vast majority of parents using the program, aptly named PoopMD, the results should provide reassurance that their newborn's stool color is normal, the investigators say. But for the one in 14,000 newborns with BA—about 400 babies each year in the United States—parents using the app can rely on it to help detect the symptomatic pale yellow to chalky grey stools that mean urgent medical assessment is needed. PoopMD is free and available for Apple and Android smartphone users.

"Days matter in diagnosing BA," says Douglas Mogul, M.D., M.P.H., a pediatric gastroenterologist at the Johns Hopkins Children's Center and lead author of the study published July 29 in *PLOS ONE*.

That's because babies with BA treated within the first two months of life have the best outcomes and are far less likely to need a liver transplant later. The first line of treatment involves surgery to repair bile ducts and restore bile flow to prevent irreversible liver damage.

Sadly, the 60-day window is all too often missed, with the average time

to diagnosis in the United States standing at 70 days.

"PoopMD does what it says it will do," says Mogul, who worked with HCB Health to create the app, first released in 2014. Among more than 100,000 medical health apps currently available, he says, only a few have been rigorously tested to see if they deliver the benefits they promise.

For the study of the app, which builds on an earlier "color card" that is distributed to new parents, the team first gathered the medical opinions of seven expert pediatricians who looked at 34 photographs of pale-colored stool. Twenty-seven of the pictures were determined to be of normal stool, and seven were deemed acholic, or bile deficient, signaling high risk for BA.

Next, one expert and three laypeople were asked to use the app on Apple and Android devices to look at and analyze the same pictures under a variety of lighting conditions and using a variety of smartphone models. "These individuals were essentially asked to take a picture of the stool photograph and determine if the app identifies the photo as normal or pale," Mogul says, "but in normal use, a parent just takes pictures of the contents of a diaper."

Even with the picture of the picture, the researchers say, the app correctly identified all of the acholic stool samples and correctly identified 24 of the 27 normal stools, while three normal stools were mislabeled "indeterminate."

"That means the app never identified a normal stool as pale, a type of false positive that could cause unnecessary anxiety for a parent or other app user," says Mogul.

Once downloaded on a smartphone, parents or caregivers use the app by taking a picture of the baby's stool and identifying the part of the picture

that has a stool color of concern. The app then immediately identifies whether the stool color matches those associated with gastrointestinal illnesses or problems with the liver, including BA.

The app can store results for future and comparative reference, and parents can email a photo to a pediatrician directly from the app. The app also reminds parents to check their newborn's stool color every two weeks.

"Four out of five adults in the U.S. ages 18-35—the age of young parents—have a smartphone, and that's independent of income level," says Mogul, "so the app gives us a great opportunity to distribute interactive content that helps young parents pay attention to educational advice."

Beyond the health and lifesaving benefits of early diagnosis and treatment of BA, Mogul says, the potential cost savings from diagnosing BA early enough are enormous, Mogul says, including avoiding a liver transplant (approximately $150,000) and ongoing immunosuppression (approximately $25,000/year) to keep the child's body from rejecting the new organ.

Mogul, who also conducted a cost-effectiveness study of the stool color cards, says widespread use of PoopMD is likely to improve medical outcomes and lower costs.

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