

4.7.A PoopMD

Biliary atresia, a disease in which the bile ducts gradually close off and block the flow of bile from the liver, is the most common reason for children to need a liver transplant. Although it is rare (about 4.5/100,000 births), its incidence appears to be increasing.(1) The disease process begins before or soon after birth, leading to a relapse or prolongation of the jaundice that is normal just after birth. There is evidence that earlier diagnosis and treatment improves outcome, hence there is interest in finding ways to make the diagnosis sooner. (2)

Because bile supplies color to the stools, one sign of biliary atresia is that the baby's stools become acholic. i.e., gray or clay-colored rather than the normal yellow, green or brown. Investigators from Johns Hopkins University(3) recently reported on a mobile phone app they call PoopMD, which parents can use to take and interpret photographs of dirty diapers to see whether the stools look acholic (Figure). (If you have a baby < 6 months old and want to participate in their study, you can download the free PoopMD+ app from Apple or Google stores.)

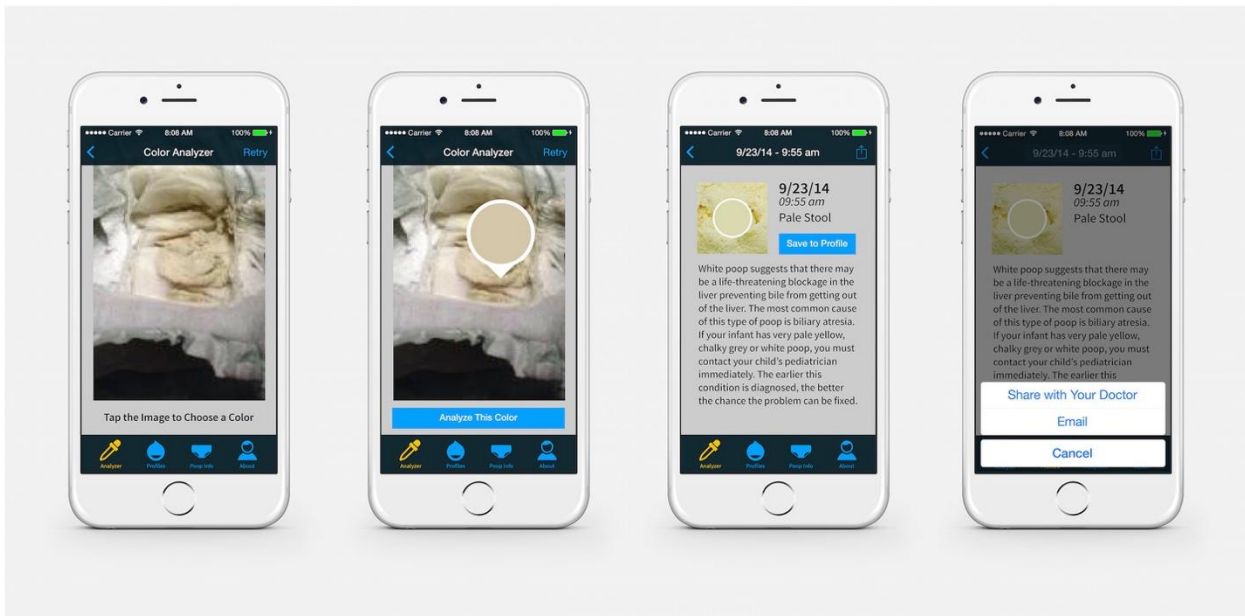


Fig 2. Screenshots demonstrating PoopMD analytic functionality.

From the abstract: "In order to define the gold standard regarding stool color, seven pediatricians were asked to review 45 photographs of infant stool and rate them as acholic, normal, or indeterminate. Samples for which 6+ pediatricians demonstrated agreement defined the gold standard, and only these samples were included in the analysis."

Table 1 from their paper is shown below.

PoopMD	Gold Standard		
	Acholic	Normal	Indeterminate
Acholic	7	0	0
Normal	0	24	0
Indeterminate	0	3	0
Total	7	27	0

- A. Counting the "Indeterminate" PoopMD rating as false positives, as the authors did, and assuming (for now) that the gold standard was accurate for biliary atresia, what would be the positive predictive value of a positive PoopMD screen in the general population, assuming a prevalence of 4.5/100,000? Show your work. [3]

LR(+) = Sens/(1-spec) = 1/(3/27) = 9 4.5/100,000 * 9 = 40.5 /100,000 = 0.04%. (Note we can safely skip the odds step because these probabilities are so small.) So, rounded to the nearest 0.1%, the posterior probability is zero. Not a very impressive test!

- B. You can see that only 34 of 45 photographs were included in the analysis. Would this be likely to bias the results? If so, name the bias and state how it would be likely to affect sensitivity and specificity. [4]

By removing all of the photographs on which the pediatricians did not agree (all the difficult ones), the authors have created an unrealistic spectrum of photographs for their study. You could say the acholic stools were the grayest of the gray and the normal stools the most normal of the normal. This is spectrum bias, which would increase both sensitivity and specificity.

- C. The gold standard here was a consensus of pediatricians about the color of the stool, rather than the actual presence or absence of biliary atresia. We might therefore be concerned that the gold standard was imperfect. If that were the case, in what direction do you think it would bias the estimates of sensitivity and specificity? Explain your answer. To get full credit you must commit yourself, not hedge. [4]

This is imperfect gold standard bias; the question is what direction would it go. In this case, both the pediatricians assessing the color of the stool and PoopMD are looking at the same aspect of the disease: stool color, so their errors are likely to be positively correlated. (They both would be falsely negative if a biliary atresia patient did not have acholic (appearing) stools and both would be falsely positive if a baby without biliary atresia did have acholic (appearing) stools So both sensitivity and specificity are over estimated.

1. Hopkins PC, Yazigi N, Nylund CM. Incidence of Biliary Atresia and Timing of Hepatoporoenterostomy in the United States. J Pediatr. 2017;187:253-7.

2. Lien TH, Chang MH, Wu JF, Chen HL, Lee HC, Chen AC, et al. Effects of the infant stool color card screening program on 5-year outcome of biliary atresia in Taiwan. *Hepatology*. 2011;53(1):202-8.
3. Franciscovich A, Vaidya D, Doyle J, Bolinger J, Capdevila M, Rice M, et al. PoopMD, a Mobile Health Application, Accurately Identifies Infant Acholic Stools. *PLoS One*. 2015;10(7):e0132270.