Test Definition: MAMMX

6-Monoacetylmorphine (6-MAM)
Confirmation, Chain of Custody, Meconium

Overview

Useful For

Detecting in utero heroin exposure up to 5 months before birth

Chain of custody is required whenever the results of testing could be used in a court of law. Its purpose is to protect the rights of the individual contributing the specimen by demonstrating that it was always under the control of personnel involved with testing the specimen; this control implies that the opportunity for specimen tampering would be limited. Since the evidence of illicit drug use during pregnancy can be cause for separating the baby from the mother, a complete chain of custody ensures that the test results are appropriate for legal proceedings.

Additional Tests

Test Id	Reporting Name	Available Separately	Always Performed
COCH	Chain of Custody Processing	No	Yes

Special Instructions

- Clinical Toxicology CPT Code Client Guidance

Method Name

Liquid Chromatography Tandem Mass Spectrometry (LC-MS/MS)

NY State Available

Yes

Specimen

Specimen Type

Meconium

Ordering Guidance

This test is for situations that require the chain-of-custody process. For testing **not** requiring chain of custody, order 6MAMM / 6-Monoacetylmorphine (6-MAM), Confirmation, Meconium

Shipping Instructions

The laboratory recommends sending chain-of-custody specimens by overnight shipment.

Specimen Required

Supplies: Chain of Custody Meconium Kit (T653)

Container/Tube: Chain of custody kit containing the specimen containers, seals, and documentation required
Specimen Volume: 1 g (approximately 1 teaspoon)
Collection Instructions:
1. Collect entire random meconium specimen in the container provided. Seal and submit with the associated documentation to satisfy the legal requirements for chain-of-custody testing.
2. Send specimen frozen. When refrigerated, a significant percentage of 6-monoacetylmorphine will convert to morphine in less than 24 hours.
Additional Information: Specimen that arrives with a broken seal does not meet the chain-of-custody requirements.

Forms

1. Chain of Custody Request is included in the Chain of Custody Meconium Kit (T635).
2. If not ordering electronically, complete, print, and send a Therapeutics Test Request (T831) with the specimen.

Specimen Minimum Volume

0.3 g (approximately 1/4 teaspoon)

Reject Due To

Grossly bloody	Reject; Pink OK
Stool	Reject
Diapers	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Meconium	Frozen	14 days	

Clinical & Interpretive

Clinical Information

Heroin (diacetylmorphine) is a semisynthetic opiate that is closely related to morphine. It is no longer used clinically in the United States, although it is used elsewhere for rapid relief of pain.(1) Like morphine and other opiates, its relaxing and euphoric qualities make heroin a popular drug of abuse. Heroin is commonly injected intravenously but can be administered by other means, such as snorting, smoking, or inhaling vapors.

Heroin shares the core structure of morphine with the addition of 2 acetyl groups, which are thought to enhance its permeation into the central nervous system.(2,3) Heroin is metabolized by sequential removal of these acetyl groups; loss of the first acetyl converts heroin into 6-monoacetylmorphine (6-MAM).(2,3) Heroin is rarely found in meconium since only 0.1% of a dose is excreted unchanged. 6-MAM is a unique metabolite of heroin, and its presence is a definitive indication of heroin use. Like heroin, 6-MAM has a very short half-life; however, its detection time in meconium, the first fecal material passed by the neonate, is uncharacterized. 6-MAM is further metabolized into morphine, the dominant metabolite of heroin, and morphine will typically be found in a specimen containing 6-MAM.

Opiates, including heroin, have been shown to readily cross the placenta and distribute widely into many fetal tissues.(4) Opiate use by the mother during pregnancy increases the risk of prematurity and being small for gestational age. Furthermore, infants who have been exposed to heroin exhibit an early onset of withdrawal symptoms compared with infants who have been exposed to methadone. Infants exposed to heroin demonstrate a variety of symptoms including irritability, hypertonia, wakefulness, diarrhea, yawning, sneezing, increased hiccups, excessive sucking, and seizures. Long-term intrauterine drug exposure may lead to abnormal neurocognitive and behavioral development as well as an increased risk of sudden infant death syndrome.(5)

The disposition of drug in meconium is not well understood. The proposed mechanism is that the fetus excretes the drug into bile and amniotic fluid. The drug accumulates in meconium either by direct deposit from bile or through swallowing of amniotic fluid.(6) The first evidence of meconium in the fetal intestine appears at approximately the 10th to 12th week of gestation, and it slowly moves into the colon by the 16th week of gestation.(7) Therefore, the presence of drugs in meconium has been proposed to be indicative of in utero drug exposure during the final 4 to 5 months of pregnancy, a longer historical measure than is possible by urinalysis.(6)

Chain of custody is a record of the disposition of a specimen to document each individual who collected, handled, and performed the analysis. When a specimen is submitted in this manner, analysis will be performed in such a way that it will withstand regular court scrutiny.

Reference Values

Negative

Positive results are reported with a quantitative liquid chromatography tandem mass spectrometry result.
Cutoff concentration: 5 ng/g

Interpretation

The presence of 6-monoacetylmorphine (6-MAM) in meconium is definitive for heroin use by the mother. However, the absence of 6-MAM does not rule out heroin use because of its short half-life.

Cautions

Because the results of this test may have legal ramifications, it is recommended that testing be performed using chain of custody. A kit including all the materials necessary to complete chain of custody is available to ensure the test results are appropriate for legal proceedings.

The short half-life of 6-monoacetylmorphine (6-MAM) may prevent its detection in heroin users.

6-monoacetylmorphine is metabolized to morphine, but the presence of morphine alone is not sufficient evidence to prove heroin use. 6-MAM is the only definitive metabolite of heroin.

Clinical Reference

1. Giovannelli M, Bedforth N, Aitkenhead A. Survey of intrathecal opioid usage in the UK. Eur J Anaesthesiol. 2008;25(2):118-122
2. Levine B, ed. Principles of Forensic Toxicology. 4th ed. AACC Press; 2013
3. Brunton LL, Hilal-Dandan R, Knollmann BC, eds. Goodman and Gilman's: The Pharmacological Basis of Therapeutics. 13th ed. McGraw-Hill; 2018

4. Szeto HH. Kinetics of drug transfer to the fetus. Clin Obstet Gynecol. 1993;36(2):246-254
5. Kwong TC, Ryan RM. Detection of intrauterine illicit drug exposure by newborn drug testing. Clin Chem. 1997;43(1):235-242
6. Ostrea EM Jr, Brady MJ, Parks PM, Asensio DC, Naluz A. Drug screening of meconium in infants of drug-dependent mothers: an alternative to urine testing. J Pediatr. 1989;115(3):474-477
7. Ahanya SN, Lakshmanan J, Morgan BL, Ross MG. Meconium passage in utero mechanisms, consequences, and management. Obstet Gynecol Surv. 2005;60(1):45-56; quiz 73-74
8. Langman LJ, Bechtel LK, Holstege CP. Clinical toxicology. In: Rifai N, Chiu RWK, Young I, Burnham CAD, Wittwer CT, eds. Tietz Textbook of Laboratory Medicine. 7th ed. Elsevier; 2023:chap 43
9. Baselt RC. Disposition of Toxic Drugs and Chemical in Man. 12th ed. Biomedical Publications; 2020

Performance

Method Description
Meconium is mixed with internal standard and extracted with methanol. The methanolic extract is further processed by solid-phase extraction. The extract is analyzed by liquid chromatography tandem mass spectrometry.(Unpublished Mayo method)

PDF Report
No

Day(s) Performed
Monday through Sunday

Report Available
2 to 3 days

Specimen Retention Time
2 weeks

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Superior Drive

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification

Test Definition: MAMMX

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Confirmation, Chain of Custody, Meconium

This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. It has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information

G0480
80356 (if appropriate for select payers)
Clinical Toxicology CPT Code Client Guidance

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
MAMMX	6-MAM Confirmation, CoC, M	29345-6

Result ID	Test Result Name	Result LOINC® Value
36202	6-Monoacetylmorphine	29345-6
36203	Interpretation	69050-3
36204	Chain of Custody	77202-0