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Use of Direct Reading Surface Sampling Methods for Site Characterization and Remediation of Methamphetamine Contaminated Properties*,†

ABSTRACT: Residual methamphetamine contamination in Clandestine laboratories represents a hazard to emergency response personnel, remediation workers and the general public. To address this threat, two rapid, sensitive surface sampling techniques to assess the location and level of methamphetamine contamination were developed. Both methods employ established industrial hygiene surface sampling materials (wipes and swabs) but differ in their sensitivity and detection technology. One method, based on colorimetric disclosure, detects and confirms a collected sample or visible residues. The second method uses a lateral flow immunochemical assay (LFIA) for semi-quantitative detection of trace contamination. The National Institute for Occupational Safety and Health (NIOSH) partnered with public health agencies to develop applications of the methods for assessment of methamphetamine contamination of suspected properties. These applications focused on safe strategies for site assessment, hazard characterization, and remediation effectiveness. To conduct the field studies, NIOSH researchers and their partners visited more than a dozen suspected laboratories including mobile labs, abandoned properties, occupied residences, and motel rooms. NIOSH found greater than 95% agreement between positive identification of the presence of methamphetamine by LFIA and laboratory-based, liquid chromatography mass spectroscopy (LC–MS) methods. Test results were used to develop site assessments and make personal protective equipment recommendations. Results were also used to conduct process-based decontamination of properties and to make health-based decisions on remediation, re-occupancy of residences, as well as determine the degree of contamination of personal property in an inactive clandestine laboratory. By partnering with stakeholders, NIOSH was able to achieve two primary goals: (1) to develop a level of awareness in health department sanitarians, law enforcement personnel and other first responders that methamphetamine surface contamination was a potentially significant route of exposure; (2) to validate our methods in the field and to develop protocols for proper use and interpretation of the results.

KEYWORDS: clandestine lab, methamphetamine, surface wipe, real-time, direct reading

Introduction

According to the United States Drug Enforcement Agency (US DEA) discovery of clandestine methamphetamine laboratories peaked at 17 000 in 2003–2004. State and federal laws restricting availability of methamphetamine precursors, particularly pseudoephedrine or ephedrine, have led to initial decreases in Clandestine laboratory discoveries or seizures [1]. However, thousands are still found each year (http://www.justice.gov/dea/concern/map_lab_seizures.html). Small-scale methamphetamine laboratories supply approximately 20% of the US methamphetamine supply [2,3], and this number is expected to increase [4]. Residual contamination of clandestine methamphetamine laboratories represents a hazard to emergency response personnel, remediation workers and the general public [5–7].

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In a series of studies, researchers from National Jewish Health and the National Institute for Occupational Safety and Health (NIOSH) along with law enforcement and public health agencies examined suspect clandestine laboratories for the presence of hazardous chemicals and methamphetamine contamination. These studies looked at exposures after police seizures and during controlled methamphetamine synthesis or "cooks" [8,9] during a control "cook" and the following 24 h [9], and during simulated methamphetamine smoking [10]. Findings from these studies found that during active methamphetamine manufacture or smoking, airborne exposures to toxic chemicals and methamphetamine were often elevated but airborne concentrations decreased significantly after 24 h. Surface contamination by methamphetamine does remain a significant risk for dermal exposures and transfer from surfaces to unprotected individuals can occur long after manufacturing ceases and is possible at locations far from the actual manufacturing process [8,11].

Reducing risks for methamphetamine exposures involves awareness of surface contamination; especially the risks for contact transfer of methamphetamine to hands and other skin surfaces as the primary route. Permanent cleanup (or remediation) of former clandestine laboratory sites to eliminate hazards posed by residual methamphetamine presents many issues regarding the costs and responsibility for cleanup. State and Federal governments that establish standards for acceptable post-remediation contamination levels often assign responsibility for enforcement of standards to environmental and public health agencies. Because of the high cost of complete remediation, owners often abandon properties rather than undertake the financial burdens of remediation. NIOSH has developed numerous methods for surface sampling and analysis to detect methamphetamine on surfaces.

Three traditional industrial hygiene methods were developed and validated for the NIOSH manual of analytical methods (NMAM), specifically NMAM 9106, 9109, and 9111. The methods all use mass spectroscopy and isotopic dilution but differ in sample preparation and analysis. NMAM 9106 and 9109 are gas chromatography/mass spectroscopy (GC/MS) methods, and 9111 is liquid chromatography/mass spectroscopy (LC/MS) method. NIOSH has also developed a surface plasmon resonance method for real time quantitative analysis of methamphetamine on surfaces [12]. While laboratory methods are sensitive and accurate they do have shortcomings. Surface samples need to be collected, transported to the laboratory and analyzed, a time consuming process requiring specialized equipment and trained personnel. In light of this, NIOSH was contacted by law enforcement and public health agencies to develop rapid tests that could be used in the field with minimal training. This manuscript describes the development and validation of rapid, sensitive surface sampling technologies to assess the location and level of methamphetamine contamination in clandestine labs. Two technologies were developed in tandem. The first method is for initial confirmation of the presence of methamphetamine in bulk samples and surface residues (colorimetric method) and the second, a sensitive, semi-quantitative detection method is used to determine the extent of contamination and assess remediation effectiveness (immunochemical method).

The goal of this study was to validate both the colorimetric and immunochemical surface sampling and detection techniques for methamphetamine by subjecting the methods to laboratory and field validation tests. Accuracy and sensitivity was determined in the laboratory and in field testing. Aside from using the technologies to assure compliance to state and local surface limits, NIOSH partnered with the Hamilton County Health District (OH) to use the tests to: (1) perform risk assessments and assess the potential of cross contamination to workers involved in the demolition of a former laboratory; (2) evaluated application of the tests to assess decontamination; (3) assess cross contamination from surfaces in rental property that was a former methamphetamine laboratory; and (4) assess the potential for contamination to personal items brought into a contaminated residence.

Experimental

Reagents

All chemicals used in this work were reagent grade or greater purity. Methamphetamine- HCl, acetaldehyde, sodium nitroprusside, sodium carbonate, methanol, phosphate buffered saline, and Triton-X100 were obtained from Sigma–Aldrich (Milwaukee, WI).

Antibodies to methamphetamine and methamphetamine conjugates were purchased from Arista Biologicals Inc. (Allentown, PA). Lateral flow immunoassays (LFIA) were assembled under contract by Arista Biologicals to NIOSH specification.

Deionized water (18 MΩ) was produced using a Barnstead nanopure system (Thermolyne, Dubuque, IA).

Materials

Cotton-tipped wooden swabs (Fisher # 23-400-100), 2 × 2 gauze wipes (North Safety Products, # 041975D) 3 × 3 gauze wipes (North Safety Products # 041980D), 5 and 10 ml disposable syringes, disposable weigh boats, 50 ml plastic centrifuge tubes, and disposable nitrile laboratory gloves were purchased from Fisher Scientific (Pittsburg, PA). Plastic pump spray bottles (vol. ≈150 ml) were purchased from U.S. Plastics (Lima, OH). Ceramic tiles (U.S. Ceramic Tile 4-1/4 × 4-1/4 in.) were purchased at a local building supply store (Home Depot, Cincinnati, OH).

Sample Handling

All laboratory and field sample collection was carried out while wearing clean nitrile gloves; to prevent cross contamination gloves were changed each time a new test was performed. Appropriate personal protection equipment was worn at all times during laboratory and field procedures. Methamphetamine was stored and standard solutions were prepared in a USDEA licensed laboratory and all research activities were in compliance with USDEA guidelines and rules.

The colorimetric indicator solution was Simon's reagent [13] prepared in a two part solution. Each solution was stored in separate 150 ml plastic spray bottles.

Solution A: 3 g of sodium nitroprusside was dissolved in 150 ml of distilled water and 6 ml of acetaldehyde was added to the solution with thorough mixing.

Solution B: 2% sodium carbonate in distilled water.

Phosphate buffered saline (PBS) containing 0.1% Triton X-100 was used as the immunochemical assay buffer. Dry pre-packaged PBS was dissolved in 1 l of deionized water and 1.0 ml Triton X-100 was added. Buffer was stored at ambient temperature for up to 14 days.

Methamphetamine stock solutions (1 mg/ml or 100 μg/ml) were prepared in methanol and diluted in PBS-Triton X-100 (0.1%) to the appropriate concentration such that 1 ml applied to the test surface gave the desired concentration.

Procedures

Colorimetric Methamphetamine Test: Laboratory Evaluation and Validation—The colorimetric method allows for rapid sampling, detection and confirmation of methamphetamine in visible residues and suspect surfaces. A surface suspected of being contaminated with methamphetamine is wiped with a cotton pad wetted with PBS-Triton X-100. The presence of methamphetamine is then disclosed on the wipe by applying two sprays of chemical reaction solution (Solution A), followed by four sprays of disclosing solution (Solution B). The results of the test are immediate: a color change to blue indicates the presence of methamphetamine.

For the determination of the linear response of the colorimetric method, serial twofold dilutions (1000–0 μg) of methamphetamine in 100 μl were added to separate wells of 96 well microtiter plates. Solution A (50 μl) and Solution B (100 μl) was added and the plate was transferred to a Molecular Devices SpectraMax plate reader, mixed by shaking and absorbance determined at 550 nm. The procedure was repeated with methamphetamine samples of different purity.

For the determination of sensitivity of the colorimetric method, methamphetamine in sampling buffer was applied to 4 × 4 in glazed ceramic tiles and allowed to dry undisturbed overnight. Applied methamphetamine ranged from 500 to 0 μg per tile. Tiles were randomized and the test operator was blinded to the level of methamphetamine on each tile. The test operator placed a 10 × 10 cm template on the area to be sampled, folded the 2 × 2 in cotton gauze wipe twice to form a sharp edge and wiped the surface to be sampled with firm pressure, using 3–4 vertical S-strokes, followed by 3–4 horizontal S-strokes, and finally wiped the area with 3–4 vertical S-strokes. The sample wipe was placed in a plastic weigh boat, with the portion of the wipe in contact with the sampled surface facing upward. Two sprays of Solution A and four sprays of Solution B were applied to the wipe and observed for formation of a blue color bloom indicative of the positive presence of methamphetamine. Tests were repeated three times with three different operators. Method sensitivity was calculated by plotting test results as a four parameter curve and determining the limit of identification based on the correct identification of the presence of methamphetamine 95% of the time.

Immunochemical Detection of Methamphetamine-Laboratory Validation—An immuno-chromatographic LFIA for the specific detection of methamphetamine was developed. The handheld test gives

binary results indicated by the presence of a single line for a positive test of methamphetamine; a negative test resulted in the formation of two lines. Because different localities and states have different limits for surface residues, test procedures were developed for 50, 100, and 500 ng. To conduct a test the test operator placed a 10×10 cm template on the area to be sampled. The surface to be tested is wiped with a swab or gauze pad moistened with PBS-Triton X-100 as described for the colorimetric method. For swab samples (50 ng), after wiping the surface the swab was placed in a vial containing an extraction solution (PBS-Triton-X-100). After gently shaking the vial, three drops of the solution are dropped on the sample well of the LFIA and the test placed on a level surface to develop. LFIA tests for 100 and 500 ng use cotton gauze wipes and a simple extraction procedure where the sample wipe is placed in a syringe and extraction buffer added. The extracted sample is expressed from the syringe by the plunger and the extract tested as described above.

Determination of Immunochemical Method Accuracy—LFIA accuracy tests were conducted with 10 untrained volunteers. Ceramic tiles were spiked with known concentrations of methamphetamine in methanol and allowed to dry overnight. Following a short training session, volunteers performed wipe tests on individual tiles with either cotton swabs (LFIA 50 ng/ 100 cm^2), or 2×2-inch cotton wipes (LFIA 100 ng/ 100 cm^2), or 3×3-inch cotton wipes (LFIA 500 ng/ 100 cm^2) as described above ($n = 480$ tests). Test operators changed gloves between each wipe test to avoid cross contamination. Bayesian analysis was performed on results obtained by volunteers with the following terms and calculations:

TP = true-positive diagnostic test result.
TN = true-negative diagnostic test result.
FN = false-negative diagnostic test result.
FP = false-positive diagnostic test result.

Diagnostic Sensitivity = $[TP/(TP + FN)] \times 100$. Defined as the percentage of positive methamphetamine tests on surfaces with known contamination (spiked laboratory surface).

Diagnostic Specificity = $[TN/(FP + TN)] \times 100$. Defined as the percentage of negative methamphetamine tests on surfaces with no known contamination (clean laboratory surface).

Receiver operating characteristics (ROC) curves were used to compare the analytical sensitivity and specificity of each assay by demonstrating the ability of each test to discriminate between alternative outcome states. Curves were prepared and analyzed using GRAPHROC for Windows (version 2.0; downloaded from http://members.tripod.com/refstat/grdownload.htm). On the *y* axis, sensitivity, or the true-positive fraction, was plotted. On the *x* axis, the false-positive fraction (or 1- specificity) was plotted. The closer the ROC plot is to the upper left corner, the higher the overall accuracy of the test.

Comparison of LFIA Surface Detection Method to NMAM 9111, LC-MS With Isotopic Dilution—Ceramic tiles were spiked with known concentrations of methamphetamine in methanol and allowed to dry overnight. For the LFIA tests, volunteers performed wipe tests on the tiles with either cotton swabs (LFIA 50), 2×2 cotton wipes (LFIA 100) or 3×3 cotton wipes (LFIA 500) as described above. For detection of methamphetamine on spiked surfaces by liquid chromatography mass spectroscopy (LC-MS) (NMAM 9111), ceramic tiles were spiked with known concentrations of methamphetamine in methanol and allowed to dry overnight. In a separate, methamphetamine-free laboratory, 3×3 wipes were wet with 1 ml reagent grade methanol and individually placed into plastic centrifuge tubes and sealed. Upon entering the detection area, the gauze was taken out of the tubes prior to wiping the designated surface. After sampling, the wipes were put back into the centrifuge tubes and NMAM method 9111 was used for quantitative analysis (ALS Laboratory Group formerly DataChem Laboratories, Salt Lake City, UT).

Field Evaluation and Validation of Tests—The surface wipe methods were field tested in clandestine methamphetamine laboratories in Ohio and Kentucky. Upon invitation from law enforcement and public health agencies NIOSH researchers performed entry into suspect clandestine laboratories. Wipe samples for methamphetamine were collected by wiping a 100 cm^2 area with either sterile cotton swabs for immunochemical analysis, or sterile 3 in. by 3 in. (3" × 3") gauze wipes for either colorimetric detection or chemical analysis. Cross contamination of sampling sites was minimized by using separate pairs of gloves between

sample locations. On-site methamphetamine detection was performed as described above. For samples that were analyzed by LC/MS, prior to entering the methamphetamine cook area, the 3×3 wipes were wetted with 1 ml of reagent grade methanol and individually placed into plastic centrifuge tubes. After entering the cook area, the gauze was taken out of the tubes prior to wiping the designated surface. After sampling, the wipes were put back into the centrifuge tubes and quantitative laboratory testing by NMAM 9111 was performed (ALS Laboratory Group, formerly DataChem Laboratory Salt Lake City, UT.)

Process-Based Assessment of Decontamination of a Former Methamphetamine Laboratory in a Hotel Room—NIOSH and Hamilton County (OH) Public Health, Environmental Health Division researchers performed initial wipe sampling of a hotel room methamphetamine laboratory immediately after it was seized by law enforcement. Colorimetric, immunochemical and LC/MS (NMAM 9111) samples were taken for an initial assessment of contamination and results were used to advise a commercial cleaning company how to proceed. After initial cleaning efforts, the sample locations were re-tested and the cleaning crew was advised on areas in need of further decontamination. The process of cleaning/re-testing was repeated until all contamination was below method limits.

Assessment of Methamphetamine Transfer From a Contaminated Former Methamphetamine Laboratory to Personal Property Brought into the Residence—The Hamilton County (OH) Public Health, Environmental Health Division was notified regarding health complaints from tenants of a rental property that was a suspected former methamphetamine laboratory. Law enforcement confirmed that the property had been under surveillance but, no arrests were made. Interviews by personnel from the Environmental Health Division with the property owner confirmed that he had removed materials consistent with a methamphetamine laboratory (pseudoephedrine packaging, solvent containers, etc.,) while cleaning the house between tenants. Based on these findings NIOSH was contacted to assist in sampling the residence and personal property. Over 200 wipe samples were taken for analysis by colorimetric, immunochemical and LC/MS methods. Samples were divided between the structure of the residence and materials brought into the residence by the new tenants. Locations of objects were mapped in relation to permanent structures of the house as well as location in relation to HVAC outlets to determine sources of contamination. Finally, the direct read methods were used by the Environmental Health Division to oversee a process-based decontamination of the property.

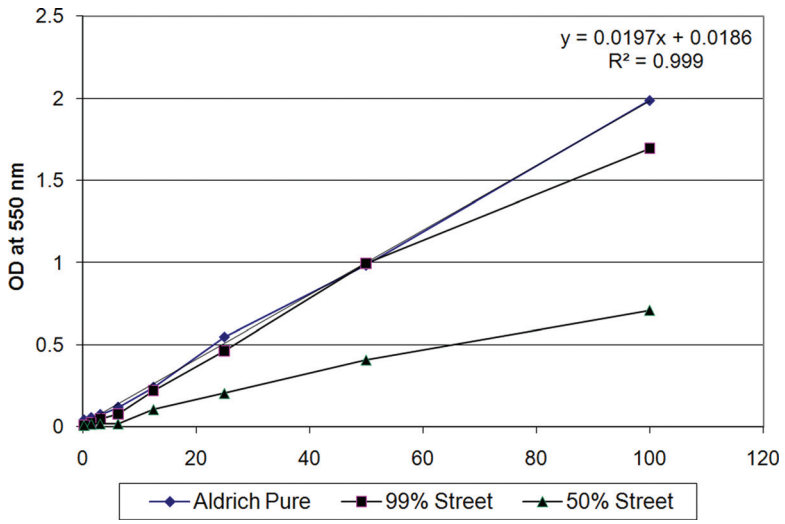

FIG. 1—*Determination of linearity of blue color formation by the reaction of Simon's reagent with methamphetamine. Standard curve of blue color formed (absorbance at 550 nm) by the reaction of methamphetamine (0–100 μg) with Simon's reagent. The procedure was repeated with methamphetamine samples of different purity.*

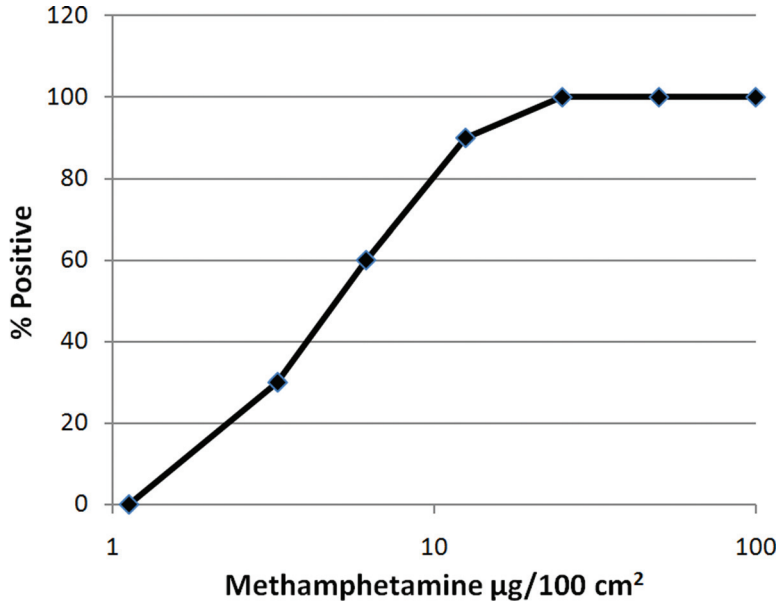

FIG. 2—*Estimation of the colorimetric methamphetamine surface sampling method. Method sensitivity was calculated by plotting test results from three volunteers as a four parameter logistic curve* $[y = y_0 + (a/(1 + ((x/x_o)^b)))]$. *Method limit of identification (LOI) was determined to be 17.362.2 µg/100* cm^2 *for 95% of users when methamphetamine present +/-25% stated cut-off.*

TABLE 1—*Determination of the method accuracy of LFIA surface wipe methods for methamphetamine: Method accuracy tests were conducted with 10 untrained volunteers (3 trials/concentration). For the LFIA tests, volunteers performed wipe tests on spiked tiles with either cotton swabs (LFIA 50),* 2×2 *cotton wipes (LFIA 100) or* 3×3 *cotton wipes (LFIA 500) as described in the text (*$n = 540$ *tests).*

LFIA 50 [1 ml, 50 ng cutoff (C.O.)]

Test #	Methamphetamine ng/100 cm^2	% C.O.	Positives(%)	Negatives (%)
1	0	0	0	100
2	50	CO	90	10
3	50	CO	90	10
4	50	CO	100	0
5	40	80	90	10
6	60	120	100	0

LFIA 100 [2 ml, 100 ng cutoff (C.O.)]

Test #	Methamphetamine ng/100 cm^2	% C.O.	Positives (%)	Negatives %)
1	0	0	0	100
2	100	CO	100	0
3	100	CO	100	0
4	100	CO	100	0
5	80	80	100	0
6	120	120	100	0

LFIA 500 [10 ml, 500 ng cutoff (C.O.)]

Test #	Methamphetamine ng/100 cm^2	% C.O.	Positives (%)	Negatives (%)
1	0	0	0	100
2	500	CO	100	0
3	500	CO	100	0
4	500	CO	100	10
5	400	80	90	10
6	600	120	100	0

Results and Discussion

Colorimetric Methamphetamine Test: Laboratory Evaluation and Validation

The colorimetric method uses Simon's reagent, a solution of sodium nitroprusside and acetaldehyde that reacts with secondary amines to produce a deep blue color under basic conditions. The reagent has been used to identify methamphetamine in urine samples [14] and in bulk samples [13] and commercial tests are available to detect methamphetamine on surfaces. However, until this study there had not been a formal validation of the method to determine test accuracy and detection limits on surfaces.

Blue color formed by the reaction of Simon's reagent with methamphetamine was found to be linear from 0 to 500 μg. The intensity of color was directly proportional to the concentration of methamphetamine present. Intensity of color is directly related to the purity of methamphetamine from different sources (Fig. 1).

Based on tests with multiple users and various concentrations of methamphetamine, the colorimetric wipe method limit of identification (LOI) was determined to be 17.3 ± 2.2 μg/100 cm^2 for 95% of users when methamphetamine was present + /-25% stated cut-off (Fig. 2).

Immunochemical Detection of Methamphetamine-Laboratory Validation

The immunochemical sampling and detection methods were found to be accurate and sensitive when used by volunteers with limited training (Tables 1–2). Diagnostic sensitivity was 92% when methamphetamine is present + /-25% stated cut-off [$(259/259 - 21) \times 100$].

Diagnostic specificity was found to be 100% [$(18/0 - 18) \times 100$]. Method accuracy was greater than 95% to identify presence/absence of methamphetamine (460/480 correct). Method sensitivity was greater

TABLE 2—*Determination of the method sensitivity of LFIA surface wipe methods for methamphetamine: Method sensitivity tests were conducted with 10 untrained volunteers (3 trials/concentration). For the LFIA tests, volunteers performed wipe tests on spiked tiles with either cotton swabs (LFIA 50), 2 × 2 cotton wipes (LFIA 100) or 3 × 3 cotton wipes (LFIA 500) as described in the text (n = 540 tests).*

LFIA 50 [1 ml, 50 ng cutoff (C.O.)]				
Methamphetamine ng/100 cm^2	% C.O.	Positives (%)	Negatives (%)	Equivocal (%)
0	0	0	100	0
25	−50	60	40	0
38	−25	80	20	0
50	C.O.	100	0	0
63	+25	100	0	0
75	+50	100	0	0
LFIA 100 [2 ml, 100 ng cutoff (C.O.)]				
Methamphetamine ng/100 cm^2	% C.O.	Positives (%)	Negatives (%)	Equivocal (%)
0	0	0	100	0
50	−50	90	10	0
75	−25	90	10	0
100	C.O.	100	0	0
125	+25	100	0	0
150	+50	100	0	0
LFIA 500 [10 ml, 500 ng cutoff (C.O.)]				
Methamphetamine ng/100 cm^2	% C.O.	Positives (%)	Negatives (%)	Equivocal (%)
0	0	0	100	0
250	−50	90	10	0
380	−25	90	10	0
500	C.O.	100	0	0
630	+25	100	0	0
750	+50	100	0	0

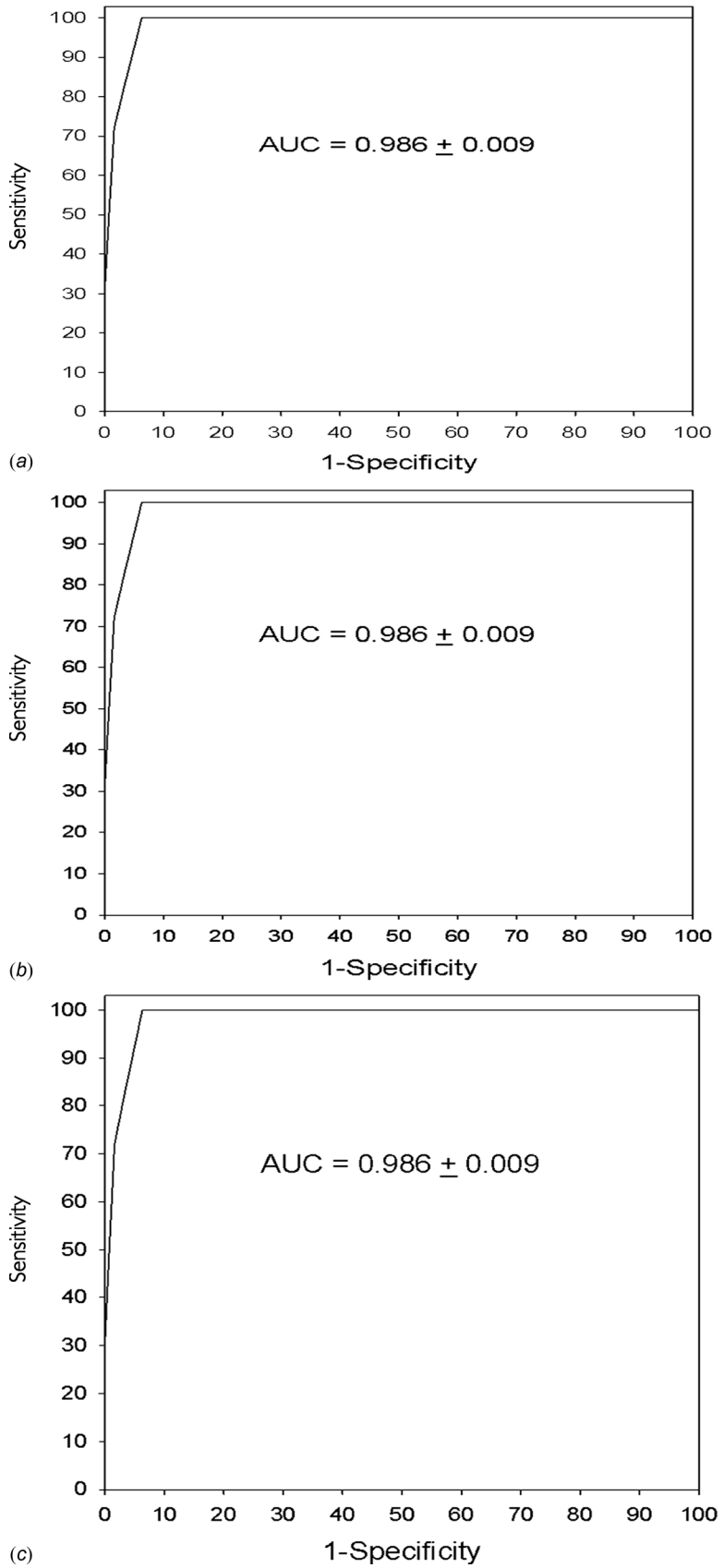

FIG. 3—*ROC curves based on LFIA surface wipe tests. Sensitivity, or the true-positive fraction, was plotted on the Y axis. The false-positive fraction (or 1- specificity) was plotted on the X axis. Accuracy was measured by calculating the area under the ROC curve (AUC). An area of 1 represents an ideal test; values near 0.5 represent an indiscriminant test. A = 50 ng LFIA, B = 100 ng LFIA and C = 500 ng LFIA.*

than 95% when methamphetamine was present +/-25% of the stated cut-off. ROC curve analysis found the methods to be very accurate (Fig. 3). Accuracy is measured by calculating the area under the ROC curve (AUC). The LFIA 50, 100, and 500 were all found to have AUCs greater than 0.98. An AUC of 1 represents an ideal test; values near 0.5 represent an indiscriminant test.

Comparison of LFIA Surface Detection Method to NMAM 9111, LC-MS With Isotopic Dilution

In laboratory tests LFIA surface sampling methods were found to have equivalent or greater sensitivity to detect methamphetamine on spiked ceramic tiles compared to NMAM 9111 (Table 3).

Process-Based Assessment of Decontamination of a Former Methamphetamine Laboratory in a Hotel Room

Methamphetamine surface contamination was confirmed by the colorimetric method, LFIA (50 and 500 ng/100 cm^2) methods and LC/MS (NMAM 9111) during the initial visit. A map of the room indicating locations and levels of contamination was prepared but, not provided to the contractor hired by hotel management to clean the room. Recommendations were made as to what materials needed to be discarded (carpet, lamp shades, room air conditioner filters, and grills), laundered (drapes and bed linen) or cleaned in place (tables, desks, etc.,). Samples from the same locations as the initial visit were taken during the remediation and a second contamination map prepared. The cleaning technicians were advised to change their cleaning techniques, remove or replace certain fixtures and provided with training and a supply of the LFIA tests to perform themselves. The final inspection after further remediation efforts found all but one of the contaminated locations were below the limits of detection (Table 4) of the LFIA 50. Based on these results, Hamilton County (OH) Public Health released the room for occupancy.

Assessment of Methamphetamine Transfer From a Contaminated Former Methamphetamine Laboratory to Personal Property Brought into the Residence

Initial assessment of the residence with LFIA qualitative tests revealed extensive but, relatively low levels of surface contamination throughout the residence (positive LFIA 50 and LFIA 500). Horizontal architectural surfaces (window sills, tops of moldings, cabinets, shelves, etc.,) were found to have higher levels than vertical surfaces. Based on demonstrated surface contamination and interviews with law enforcement and the owner of the property, the location was declared a confirmed former methamphetamine laboratory and was determined by Hamilton County (OH) Public Health to be unsafe. Residents were relocated, leaving behind nearly all of their personal property. Quantitative surface wipe samples were collected and analyzed by Draft NMAM 9111. The presumed location of methamphetamine manufacturing was determined

TABLE 3—*Comparison of LFIA (50, 100, and 500) surface detection method to Draft Method 9111, LC–MS with Isotopic Dilution.*

Methamphetamine	LFIA 50	Draft 9111
0	Negative (9/9)	ND
38 ng/100 cm^2	Positive 9/9	Below reporting limit (<100 ng/100 cm^2)
50 ng/100 cm^2	Positive 9/9	Below reporting limit (<100 ng/100 cm^2)
63 ng/100 cm^2	Positive 9/9	Below reporting limit (<100 ng/100 cm^2)
Methamphetamine	**LFIA 100**	**Draft 9111**
0	Negative (9/9)	ND
75 ng/100 cm^2	Positive 9/9	Below reporting limit (<100 ng/100 cm^2)
100 ng/100cm^2	Positive 9/9	94 ± 7 ng/100 cm^2
125 ng/100 cm^2	Positive 9/9	118 ± 4 ng/100 cm^2
Methamphetamine	**LFIA 500**	**Draft 9111**
0	Negative (9/9)	ND
380 ng/100 cm^2	Positive 9/9	400 ± 11 ng/100 cm^2
500 ng/100 cm^2	Positive 9/9	490 ± 12 ng/100 cm^2
630 ng/100 cm^2	Positive 9/9	581 ± 31 ng/100 cm^2

TABLE 4—*Assessment of performance of LFIA 50, and LFIA 500 in comparison to LCMS (Draft 9111) to determine decontamination of a clandestine laboratory located in motel room.*

	Pre-Remediation			During-Remediation			After Remediation		
Location	LFIA 50	LFIA 500	LCMS (μg/100 cm^2)	LFIA 50	LFIA 500	LCMS (μg/100 cm^2)	LFIA 50	LFIA 500	LCMS (μg/100 cm^2)
Dresser A	POS	POS	11.00	POS	NEG	0.34	NEG	NEG	ND*
Dresser B	POS	POS	14.00	POS	NEG	0.07	NEG	NEG	ND
TV Stand	POS	POS	12.00	POS	POS	0.40	NEG	NEG	ND
TV	POS	POS	4.80	NEG	NEG	ND*	NEG	NEG	ND
AC vent	POS	POS	24.00	POS	POS	1.20	NEG	NEG	ND
AC return	POS	POS	26.00	POS	POS	3.20	NEG	NEG	ND
Wall	POS	POS	4.20	POS	POS	0.89	POS	NEG	ND
Table	POS	POS	1500.00	POS	POS	4.80	NEG	NEG	ND
Window	POS	POS	2.10	NEG	NEG	ND*	NEG	NEG	ND
Night stand	POS	POS	5.50	POS	NEG	0.07	NEG	NEG	ND
Drapes	POS	NEG	0.78	POS	NEG	0.13	NEG	NEG	ND

*ND = Not Detected

to have occurred in the basement (highest contamination = 18 μg/100 cm^2) and methamphetamine was found on surfaces throughout the first (highest contamination = 6.7 μg/100 cm^2) and second floors (highest contamination = 3.2 μg/100 cm^2). The furnace and HVAC ducts were contaminated and could have been an initial source of distributing methamphetamine.

To assess the levels of transfer of methamphetamine from contamination inherent to the building onto personal property, representative items were tested with 50 and 500 ng LFIA. Items that had direct physical contact with contaminated building surfaces, such as an item placed on a shelf, were frequently contaminated. Other items were found to have contamination from probable transfer by persons handling an object after coming in contact with a contaminated surface. For example, opening a window with contamination on the sill, may lead to the person transferring a portion of that contamination to the next object they handled. In all, nearly 240 tests were used to test personal property in the home. Items that were below the detection limit of the 50 ng LFIA were released immediately to the former tenants. Items that tested positive at 50 ng but, were below the detection limit of the 500 ng LFIA were cleaned by wiping with a sanitizing wipe containing quaternary ammonia, retested at 50 ng and if below the limit of detection, returned to the former tenant. Items that tested positive at the 500 ng LFIA and would cost more than one hundred dollars to replace were decontaminated if possible. Usually, a single application of a foaming cleaner containing quaternary ammonia followed by removal with a blotting motion using clean paper towels resulted in subsequent negative tests using the 50 ng LFIA. Hamilton County (OH) Public Health ultimately worked with the property owner to develop a process-based decontamination plan to return the property to a habitable status. Through a process of cleaning, testing, cleaning and re-testing, the property eventually was declared cleared for habitation.

Thousands of illicit drug laboratories are found each year. While active methamphetamine laboratories represent a significant source of toxic or potentially lethal chemical exposures [8] a majority of clandestine labs are identified long after they cease activity. Residual contamination of these clandestine laboratories represents a hazard to thousands of emergency response personnel, remediation workers and the general public. Researchers from the NIOSH developed rapid, sensitive surface sampling technologies to assess the location and level of methamphetamine contamination in clandestine labs. Two methods were developed, a colorimetric test and an immunochemical test. These technologies were developed in tandem to do initial confirmation of the presence of methamphetamine on surfaces using the colorimetric method and then use the immunochemical method as a sensitive semi-quantitative detection method to determine the extent of contamination and assess remediation effectiveness. This method is also suitable to detect contamination on personnel and equipment. The tests are simple, rapid, accurate and relatively inexpensive.

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