In March 2012, the Wyoming Department of Health was notified by Natrona County public health officials regarding three patients hospitalized for unexplained acute kidney injury (AKI), all of whom reported recent use of synthetic cannabinoids (SCs), sometimes referred to as “synthetic marijuana.” SCs are designer drugs of abuse typically dissolved in a solvent, applied to dried plant material, and smoked as an alternative to marijuana. AKI has not been reported previously in users of SCs and might be associated with 1) a previously unrecognized toxicity, 2) a contaminant or a known nephrotoxin present in a single batch of drug, or 3) a new SC compound entering the market. After the Wyoming Department of Health launched an investigation and issued an alert, a total of 16 cases of AKI after SC use were reported in six states. Review of medical records, follow-up interviews with several patients, and laboratory analysis of product samples and clinical specimens were performed. The results of the investigation determined that no single SC brand or compound explained all 16 cases. Toxicologic analysis of product samples and clinical specimens (available from seven cases) identified a fluorinated SC previously unreported in synthetic marijuana products: (1-((5-fluoropentyl)-1H-indol-3-yl) (2,2,3,3-tetramethylcyclopropyl) methanone, also known as XLR-11, in four of five product samples and four of six patients’ clinical specimens. Public health practitioners, poison center staff members, and clinicians should be aware of the potential for renal or other unusual toxicities in users of SC products and should ask about SC use in cases of unexplained AKI.

**Epidemiologic Findings**

The first three patients (Table 1, cases 1–3) reported smoking SCs in the days or hours before symptom onset. Public health staff members interviewed the three and reviewed their medical records. The patients were young, previously healthy males who reported smoking either a blueberry-flavored SC product (one patient) or an unspecified SC product (two patients). They experienced severe nausea, vomiting, and flank or abdominal pain and went to emergency departments during February 26–29. Local law enforcement officials were notified and released a media advisory warning of illness associated with SC use.

The Wyoming Department of Health launched an investigation to identify other cases and determine the cause of illness. A case initially was defined as nausea, vomiting, abdominal or back pain, and AKI (i.e., serum creatinine concentration above the facility’s reference range) in a patient reporting SC use and illness onset during February 1–March 1. Hospital staff members from two regional medical facilities conducted retrospective reviews of emergency department and hospital admission records. The Wyoming Department of Health issued a health alert on March 1 to all licensed health-care providers, hospitals, emergency departments, and urgent-care centers in Wyoming, describing the possible association between AKI and SC use and requesting that potential cases be reported.
On March 21, the Wyoming state epidemiologist contacted CDC regarding the first three cases. On March 24, a fourth Wyoming patient became ill after smoking either a blueberry-flavored or bubblegum-flavored SC product and was found to meet the case definition (Table 1, case 4).

A collaboration among several state public health officials, poison center toxicologists, forensic laboratory scientists, individual clinicians, and the Arkansas K2 Research Consortium, identified an additional 12 cases of SC-associated AKI in Oregon (six cases), New York (two), Oklahoma (two), Rhode Island (one), and Kansas (one) in hospitalized patients who had serum creatinine concentration above the facility’s reference range after smoking an SC product during March 16–December 3. CDC medical toxicologists reviewed clinical and laboratory data from all 16 cases (Table 1).

All 16 patients initially visited emergency departments and subsequently were hospitalized. The 16 patients included 15 males aged 15–33 years (median: 18.5 years) and one female aged 15 years; all but one had nausea and vomiting. Twelve patients reported abdominal, flank, and/or back pain. None reported preexisting renal dysfunction or use of medication that might have caused renal problems. The highest serum creatinine concentrations (creatinine peak) among the 16 patients ranged from 3.3 to 21.0 mg/dL (median: 6.7 mg/dL; normal 0.6–1.3 mg/dL) and occurred 1–6 days after symptom onset (median: 3 days). Urinalysis for 15 patients showed variable results: proteinuria (eight patients), casts (five), white blood cells (nine), and red blood cells (eight). Twelve patients underwent renal ultrasonography, nine of whom had a nonspecific increase in renal cortical echogenicity; none had hydronephrosis.

Six of eight patients with a renal biopsy demonstrated acute tubular injury, and three of eight patients demonstrated features of acute interstitial nephritis. Kidney function recovery was apparent within 3 days of creatinine peak in most patients. However, five of the 16 patients required hemodialysis, and four patients received corticosteroids; none died. Other infectious, autoimmune, pharmacologic, or other toxic causes of AKI were not found.

**Toxicologic Analysis**

Of the 16 cases, toxicologic analysis of implicated SC products and clinical specimens was possible in seven (Table 2). No single SC product explained all of the cases. Two SC products recovered by law enforcement officials in Wyoming and epidemiologically linked to cases 1–3 were tested by the Arkansas K2 Research Consortium laboratory (Arkansas K2) and the University of California–San Francisco Clinical and Environmental Toxicology Laboratory (UCSF). Gas chromatography/mass spectrometry (Arkansas K2) and liquid chromatography/time-of-flight mass spectrometry (UCSF) analysis revealed that both products contained 3-(1-naphthoyl) indole, a precursor to several aminoalkylindole synthetic cannabinoids. One of the two product samples also contained the potent synthetic cannabinoid AM2201, which has been linked to human disease and death, but not to AKI.

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TABLE 1. Demographic and clinical characteristics and implicated product in 16 cases associated with synthetic cannabinoid use — multiple states, 2012

| Case no. | State                  | Patient age (yrs) | Chief symptom at presentation                              | Peak creatinine (mg/dL) | Urine microscopy results*                                                                 | Renal ultrasound results                                                                 | Implicated product                                      |
|----------|------------------------|-------------------|------------------------------------------------------------|-------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------|
| 1        | Wyoming                | 19                | Nausea and vomiting, abdominal pain                        | 5.2                     | WBCs, RBCs, RBC/ granular casts                                                           | Within normal limits                                                                         | Synthetic cannabinoid, not otherwise specified          |
| 2        | Wyoming                | 15                | Nausea and vomiting, abdominal pain                        | 6.8                     | WBCs, RBCs, RBC/ granular casts, eosinophils                                             | Increased cortical echogenicity bilaterally                                                  | Synthetic cannabinoid, not otherwise specified          |
| 3        | Wyoming                | 21                | Nausea and vomiting, flank pain                            | 6.3                     | WBCs, RBCs, epithelial casts, granular casts                                              | Not available                                                                               | Blueberry-flavored                                      |
| 4        | Wyoming                | 18                | Nausea and vomiting, flank pain                            | 4.1                     | Hyaline casts, WBCs                                                                       | No increased cortical echogenicity or hydronephrosis                                        | Blueberry-flavored or bubblegum-flavored                 |
| 5        | Rhode Island           | 25                | Nausea and vomiting, anuria                                | 21.0                    | RBCs, proteinuria, eosinophils                                                            | Not performed                                                                               | Synthetic cannabinoid, not otherwise specified          |
| 6        | New York               | 30                | Nausea and vomiting                                        | 9.0                     | WBCs, RBCs, RBC/ hyaline casts                                                           | Not performed                                                                               | Phantom Wicked Dreams                                   |
| 7        | Oregon                 | 18                | Nausea and vomiting, abdominal pain                        | 6.6                     | WBCs, protein 30                                                                          | Increased cortical echogenicity, no hydronephrosis                                         | “Synthetic marijuana”                                    |
| 8        | New York               | 33                | Nausea and vomiting, abdominal pain                        | 3.3                     | Not available                                                                              | Not performed                                                                               | Spice Gold                                               |
| 9        | Oregon                 | 27                | Flank pain                                                 | 4.7                     | Small blood, protein 30                                                                   | Normal echogenicity, no hydronephrosis                                                      | Mad Monkey or Clown Loyal                               |
| 10       | Washington/Oregon       | 15                | Nausea and vomiting, abdominal pain / back pain            | 9.1                     | Protein trace                                                                             | Increased cortical echogenicity, no hydronephrosis                                         | Synthetic cannabinoid, not otherwise specified          |
| 11       | Kansas                 | 26                | Nausea and vomiting, abdominal pain / back pain            | 7.7                     | Within normal limits                                                                      | Increased cortical echogenicity                                                             | Mr. Happy                                                |
| 12       | Oregon                 | 17                | Nausea and vomiting, flank pain                            | 10.6                    | WBCs, RBCs, protein 2+, eosinophils 1+                                                    | Increased cortical echogenicity, no hydronephrosis                                         | Clown Loyal                                              |
| 13       | Oregon                 | 18                | Nausea and vomiting, abdominal pain                        | 9.6                     | Protein 2+, blood 3+, no RBCs                                                            | Increased cortical echogenicity, no hydronephrosis                                         | Lava                                                    |
| 14       | Oregon                 | 18                | Nausea and vomiting, abdominal pain                        | 5.5                     | Protein 1+                                                                                | Increased cortical echogenicity, no hydronephrosis                                         | Lava                                                    |
| 15       | Oklahoma               | 15                | Nausea and vomiting, abdominal pain                        | 11.5                    | WBCs, RBCs                                                                               | Increased cortical echogenicity, bilateral symmetrical enlargement                           | Flame 2.0                                               |
| 16       | Oklahoma               | 15†               | Nausea and vomiting                                        | 6.2                     | WBC, protein 1+                                                                           | Increased cortical echogenicity                                                             | Flame 2.0                                               |

Abbreviations: WBCs = white blood cells; RBCs = red blood cells.
* Elevated levels listed if above the reporting laboratory’s reference range.
† Female patient; all others are male.
Standardized liquid chromatography–time of flight mass spectrometry methods validated for trace level analysis of synthetic cannabinoid parent compounds and metabolites were used for all clinical assays (UCSF). A sample of the product smoked by the patient in case 4 contained 3-(1-naphthoyl) indole and XLR-11, a previously undescribed fluorinated-derivative of the SC compound UR-144 currently in circulation. A urine specimen collected from the same patient was positive for the XLR-11 N-pentanoic acid metabolite. A blood specimen from the patient in case 6, who smoked “Phantom Wicked Dreams,” contained the N-pentanoic acid metabolite of XLR-11. In case 11, analysis of the SC product “Mr. Happy” and a serum specimen revealed the SCs XLR-11 and UR-144; a urine specimen contained the N-pentanoic acid metabolite of XLR-11. In case 12, samples of “Clown Loyal” were found to contain XLR-11. In cases 13 and 14, analysis of “Lava” and associated clinical specimens identified XLR-11 and the N-pentanoic acid metabolite of XLR-11. In case 15, analysis of “Flame 2.0” was negative for XLR-11. For nine of the 16 cases, neither product samples nor clinical specimens were available for analysis.

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Editorial Note

Synthetic cannabinoid compounds originally were developed to facilitate study of cannabinoid receptor pharmacology, but in recent years have emerged as drugs of abuse. In 2005, SC products marketed as “Spice” first emerged in European countries, before appearing in the United States in 2009, where they were marketed initially as “K2.” Today, SC products are distributed worldwide under countless trade names and packaged in colorful wrappers designed to appeal to teens, young adults, and first-time drug users (1). Products often are packaged with disingenuous labels such as “not for human consumption” or “incense,” although health professionals and legal authorities know these products are smoked like marijuana. Law enforcement officials, public health officials, clinicians, scientists, and the members of the public should be aware of the potential for adverse health effects posed by SCs.

What is already known on this topic?
Synthetic cannabinoids (SCs) are psychoactive chemicals dissolved in solvent, applied to plant material, and smoked as a drug of abuse. They are sold in “head shops” and tobacco and convenience stores under labels such as “synthetic marijuana,” “herbal incense,” “potpourri,” and “spice.” Most reports of adverse events related to SCs have been neurologic, cardiovascular, or sympathomimetic.

What is added by this report?
Sixteen cases of acute kidney injury following exposure to SCs were identified in six states with illness onset during March 16–December 7, 2012. Patients ranged in age from 15 to 33 years; 15 were male, and none reported a history of kidney disease. Gas and liquid chromatography and mass spectrometry identified a new SC, XLR-11, associated with some of these cases.

What are the implications for public health practice?
Novel drugs of abuse are emerging continuously. SCs often are packaged in colorful wrappers bearing labels such as “not for human consumption” or “incense,” although health professionals and legal authorities know these products are smoked like marijuana. Law enforcement officials, public health officials, clinicians, scientists, and the members of the public should be aware of the potential for adverse health effects posed by SCs.

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References

1. Fattore L, Fratta W. Beyond THC: the new generation of cannabinoid designer drugs. Front Behav Neurosci 2011;5:60.
2. Cohen J, Morrison S, Greenberg J, Saidinejad M. Clinical presentation of intoxication due to synthetic cannabinoids. Pediatrics 2012;129:e1064–7.
3. Lapoint J, James LP, Moran CL, Nelson LS, Hoffman RS, Moran JH. Severe toxicity following synthetic cannabinoid ingestion. Clin Toxicol (Phila) 2011;49:760–4.
4. Shanks KG, Dahn T, Terrell AR. Detection of JWH-018 and JWH-073 by UPLC-MS-MS in postmortem whole blood casework. J Anal Toxicol 2012;36:145–52.
5. Beharta VS, Ramirez S, Varney SM. Spice: a new “legal” herbal mixture abused by young active duty military personnel. Subst Abus 2012;33:191–4.
6. Drug Enforcement Administration. Schedules of controlled substances: temporary placement of five synthetic cannabinoids into schedule I. Washington, DC: US Department of Justice, Drug Enforcement Administration; 2011. Available at http://www.deadiversion.usdoj.gov/fed_regs/rules/2011/fr0301.htm.
7. National Conference of State Legislatures. Synthetic cannabinoids (a.k.a. “K2”/“Spice”) enactments. Washington, DC: National Conference of State Legislatures; 2012. Available at http://www.ncsl.org/issues-research/justice/synthetic-cannabinoids-enactments.aspx.
8. Forrester MB, Kleinschmidt K, Schwarz E, Young A. Synthetic cannabinoids and marijuana exposures reported to poison centers. Hum Exp Toxicol 2012;31:1006–11.
9. Hoyte CO, Jacob J, Monta AA, Al-Jumaan M, Bronstein AC, Heard K. A characterization of synthetic cannabinoids exposures reported to the National Poison Data System in 2010. Ann Emerg Med 2012;60:435–8.
10. Coca SG, Singamanala S, Parikh CR. Chronic kidney disease after kidney injury: a systemic review and meta-analysis. Kid Int 2012;81:442–8.