Heavy Metals & Essential Nutrients Testing.
Minimally-invasive home test kit.

method for testing elements. Research[2,3] has shown the dried urine test to be accurate and comparable to full 24-hour liquid samples, the collection of which are cumbersome and inconvenient for patients. To normalize results for elements extracted from the filter paper and correct for hydration status, creatinine is also measured and element test results are expressed in µg/g creatinine.

Elements Tested in the Profile

Iodine

An essential component of the thyroid hormones T4 and T3. Iodine is an essential nutrient, commonly found in dairy products, seafood, iodized salt, and grains. Severe iodine deficiency compromises thyroid hormone production and leads to serious diseases including irreversible cretinism, pregnancy complications, goiter, and decreased cognitive function[4]. Mild to moderate iodine insufficiency can lead to thyroid deficiency. Excessive iodine intake, paradoxically, can also lead to thyroid deficiency. Iodine deficiency has also been associated with breast cancer. Since over 90% of dietary iodine is eliminated in urine, adequacy of recent iodine intake can be accurately assessed with dried urine testing[5]. For a fuller discussion of iodine's role in overall health and the value of testing, please see the Provider Data Sheet "Iodine Testing in Dried Urine".

Bromine

A common component of flame proofing agents, fumigants, medications, food products, and pool/spa sanitizers. Although bromine was once thought to have no essential function in the body, recent studies suggest that it may also be an essential element at low levels and play a role in connective tissue formation[6]. High environmental exposure can lead to excess accumulation[7]. If iodine status is low, bromine competes with iodine for tyrosine binding sites within thyroglobulin and thereby impedes thyroid hormone synthesis. Bromine is mostly excreted in urine, so urine analysis can indicate excessive bromine exposure.

Selenium

An essential dietary element that is incorporated into selenoproteins in the body, which include glutathione peroxidases, thioredoxin reductases, iodothyronine deiodinases, and the extracellular glycoprotein, selenoprotein P[8]. These selenoproteins play vital roles in thyroid hormone synthesis, free radical scavenging, DNA synthesis, and cancer prevention[9]. Foods such as brazil nuts, seafood, eggs, and grains are significant selenium sources. The optimal therapeutic range for selenium is narrow. Excess selenium intake can result in toxicity, while inadequate selenium affects thyroid function because of impaired synthesis and conversion of T4 into the active T3[10]. Urine is the major route of selenium elimination; therefore urinary selenium is an indicator of dietary selenium intake.

Arsenic

An environmental toxin, found in well water as well as some foods such as fish, shellfish, seaweed, rice, and fruit. Arsenic is a heavy metal with multiple toxic effects in the body including carcinogenesis, goiter, diabetes, skin diseases, and damage to the liver, kidney, and the cardiovascular, nervous, and endocrine systems[11]. It also competes with selenium, preventing its incorporation into the selenoproteins. This reduces the levels of selenium-containing antioxidants and also the selenoenzymes that are essential for thyroid hormone production, thereby compromising thyroid function[12]. Urinary arsenic is a good indicator of recent arsenic exposure, since around 80% of dietary arsenic is excreted into urine with 3 days[13].

Mercury

A highly toxic heavy metal that can accumulate in body tissues including the brain. Besides occupational exposure, most human exposure to mercury is through dental amalgams, seafoods, and vaccinations[14]. Mercury toxicity can cause nervous system damage, leading to symptoms such as paresthesia, mood changes, and sensory disturbances, while very excessive exposure can also lead to renal toxicity, respiratory failure and death[15]. Mercury

and selenium have a very high affinity for each other and form a tight complex[16]. As a result, mercury reduces the biological availability of selenium and may inhibit the formation of selenium-dependent enzymes, affecting thyroid function in the same way as selenium deficiency or arsenic exposure. This is particularly problematic in people with inadequate selenium intake and consequent low selenium levels. Selenium can protect against mercury toxicity by sequestering mercury, reducing its bioavailability[17]. The low toxicity of mercury in fish is related to its stoichiometric interaction with selenium. There are three forms of mercury in the environment: elemental, found in batteries, thermometers, and dental amalgams; inorganic compounds, primarily mercuric chloride, present in skin-lightening creams; and organic compounds, primarily methylmercury, found in sea foods. Elemental mercury is most commonly breathed in as a vapor (e.g., from amalgams) and absorbed through the lungs, while inorganic and organic compounds are ingested and absorbed through the intestine. The predominant form of mercury in urine is inorganic mercury. Urinary mercury level is an excellent biomarker for whole body exposure to both elemental and inorganic mercury[18].

Cadmium

A toxic metal that is extremely hazardous to human health. Cadmium is classified by the World Health Organization's International Agency for Research on Cancer (IARC) as a group I carcinogen[19,20]. Occupational exposure arises mainly from smelting and battery manufacturing. Cadmium gets into the atmosphere as a result of this industrial activity, as well as via fossil fuel combustion and waste incineration, and is deposited in the soil where it is taken up by plants and thus eventually enters the human food supply[21]. Tobacco leaves are particularly efficient at accumulating high levels of cadmium from soil, and so smoking is a major source of human cadmium exposure. Smokers have about twice the body burden of cadmium compared to non-smokers. In non-smokers, the primary source of exposure is through the food supply. Particularly high levels are seen in green, leafy vegetables, potatoes and grains, peanuts, soybeans, and sunflower seeds. It also accumulates in shellfish. Apart from occupational exposure in cadmium-emitting manufacturing plants or waste incinerators, cadmium inhalation from the air is not a major source for most people. Once inside the body, cadmium binds to albumin and metallothione in in the circulation, and is filtered by the kidneys where it accumulates in the kidney cortex. In the kidneys, the half-life of cadmium is more than 10 years; urinary cadmium correlates with tissue levels in the kidneys and is thus accepted as an accurate measure of long-term total body burden of cadmium[21]. Cadmium can also accumulate in the thyroid gland, resulting in damage to thyroid tissues with chronic exposure[22]. An overall positive association has been observed between urinary cadmium and levels of total T4, total T3, free T3, and thyroglobulin in the National Health and Nutrition Examination Survey (NHANES)[23]. Cadmium contributes to unexplained infertility in both men and women, having detrimental effects on both male and female reproductive organs through a variety of mechanisms, including endocrine signal disruption and testicular accumulation affecting spermatogenesis[24,25]. Cadmium also acts as an estrogen mimic or metalloestrogen by stimulating cell proliferation in estrogen-responsive tissues and therefore increasing risk of uterine fibroids and other reproductive tract diseases[26]. Cadmium was originally thought to act by binding directly to the estrogen receptor, but recent research suggests that it circumvents the estrogen receptor and activates the zinc-finger gene region that is ordinarily activated by estrogen receptor bound to estrogen[27]. Short-term cadmium exposure, reflected in elevated blood but not urine levels, has been associated with modest blood pressure elevations[28,29], while urinary cadmium has been linked with peripheral arterial disease[30], indicating some cardiovascular toxicity with cadmium exposure.

Creatinine

A metabolic by-product that is excreted at a relatively constant rate as long as kidney function is not impaired. It is used to normalize the amount of elements extracted from the filter paper and to correct for hydration status; the greater the fluid intake, the lower the creatinine level. Iodine, bromine, selenium, arsenic, mercury, and cad-mium results are therefore expressed in µg/g creatinine to allow for urine dilution.

Advantages of Dried Urine for Testing Heavy Metals & Essential Nutrients

- Urine collection and shipment of the dried filter strips are simple and convenient for the patient and practitioner
- Dual collections of urine directly on a filter strip, upon awakening and just before bed, are far more convenient and less subject to the inherent inaccuracies of a 24-hour urine collection, yet correlate well with 24-hour urine collections
- Iodine, bromine, selenium, arsenic, mercury, cadmium, and creatinine in dried urine are exceptionally stable for weeks at room temperature allowing more flexibility in collection, shipment, testing, and storage
- Elements results expressed in µg/g creatinine allows normalization of results when problems exist with urine that is very concentrated or dilute

References

1. ATSDR Priority List of Hazardous Substances, 2013. Available at: http://www.atsdr.cdc.gov/SPL/.
2. Zava TT, Kapur S, Zava DT. Iodine and creatinine testing in urine dried on filter paper. Anal Chim Acta 2013;764:64-9.
3. Zava TT, Zava DT. Determination of iodine, bromine, selenium and arsenic by ICP-DRC-MS using urine dried on filter paper. Poster presented at the 83rd Annual Meeting of the American Thyroid Association, October 16-20, 2013, San Juan, Puerto Rico.
4. Zimmermann MB. Iodine deficiency. Endocr Rev. 2009;30:376-408.
5. WHO, UNICEF, ICCIDD, Assessment of iodine deficiency disorders and monitoring their elimination; a guide for programme managers, third ed., WHO publications, Geneva, 2007.
6. McCall AS, Cummings CF, Bhave G, Vanacore R, Page-McCaw A, Hudson BG. Bromine is an essential trace element for assembly of collagen IV scaffolds in tissue development and architecture. Cell. 2014;157:1380-92.
7. Bromism. In: Parfitt K, ed. Martindale 32nd ed. Pharmaceutical Press, 1999:1620-3.
8. Brown KM, Arthur JR. Selenium, selenoproteins and human health: a review. Public Health Nutr. 2001;4:593-9.
9. Mehdi Y, Hornick JL, Istasse L, Dufrasne I. Selenium in the environment, metabolism and involvement in body functions. Molecules. 2013;18:3292-311.
10. Bianco AC, Salvatore D, Gereben B, et al. Biochemistry, cellular and molecular biology, and physiological roles of the iodothyronine selenodeiodinases. Endocr Rev. 2002;23:38-89.
11. Kapaj S, Peterson H, Liber K, Bhattacharya P. Human health effects from chronic arsenic poisoning--a review. J Environ Sci Health A Tox Hazard Subst Environ Eng. 2006;41:2399-428.
12. Ciarrocca M, Tomei F, Caciari T, et al. Exposure to arsenic in urban and rural areas and effects on thyroid hormones. Inhal Toxicol. 2012;24:589-98.
13. Van Hulle M, Zhang C, Schotte B, et al. Identification of some arsenic species in human urine and blood after ingestion of Chinese seaweed Laminaria. J Anal At Spectrom. 2004;19:58-64.
14. Clifton JC 2nd. Mercury exposure and public health. Pediatr Clin North Am. 2007;54:237-69, viii.
15. Environmental Protection Agency. Health effects of mercury. Available at: http://www.epa.gov/hg/effects.htm.
16. Khan MA, Wang F. Mercury-selenium compounds and their toxicological significance: toward a molecular understanding of the mercury-selenium antagonism. Environ Toxicol Chem. 2009;28:1567-77.
17. Branco V, Canário J, Lu J, Holmgren A, Carvalho C. Mercury and selenium interaction in vivo: effects on thioredoxin reductase and glutathione peroxidase. Free Radic Biol Med. 2012;52:781-93.
18. Park JD, Zheng W. Human exposure and health effects of inorganic and elemental mercury. J Prev Med Public Health. 2012;45:344-52.
19. IARC Monograph 100C (2012): Cadmium and cadmium compounds. Available at: http://monographs.iarc.fr/ENG/Monographs/vol100C/mono100C-8.pdf.
20. Adams SV, Passarelli MN, Newcomb PA. Cadmium exposure and cancer mortality in the Third National Health and Nutrition Examination Survey cohort. Occup Environ Med. 2012;69(2):153-6.
21. ATSDR Public Health Statement for Cadmium; Sept. 2012. Available at: http://www.atsdr.cdc.gov/PHS/PHS.asp?id=46&tid=15.
22. Jancic SA, Stosic BZ. Cadmium effects on the thyroid gland. Vitam Horm. 2014;94:391-425.
23. Chen A, Kim SS, Chung E, Dietrich KN. Thyroid hormones in relation to lead, mercury, and cadmium exposure in the National Health and Nutrition Examination Survey, 2007-2008. Environ Health Perspect. 2013;121(2):181-6.
24. Thompson J, Bannigan J. Cadmium: toxic effects on the reproductive system and the embryo. Reprod Toxicol. 2008;25(3):304-15.
25. Benoff S, Jacob A, Hurley IR. Male infertility and environmental exposure to lead and cadmium. Hum Reprod Update. 2000;6(2):107-21.
26. Kortenkamp A. Are cadmium and other heavy metal compounds acting as endocrine disrupters? Met Ions Life Sci. 2011;8:305-17.
27. Gao X, Yu L, Moore AB, Kissling GE, Waalkes MP, Dixon D. Cadmium and proliferation in human uterine leiomyoma cells: evidence of a role for EGFR/MAPK pathways but not classical estrogen receptor pathways. Environ Health Perspect. 2015;123(4):331-6.
28. Tellez-Plaza M, Navas-Acien A, Crainiceanu CM, Guallar E. Cadmium Exposure and Hypertension in the 1999–2004 National Health and Nutrition Examination Survey (NHANES). Environmental Health Perspectives. 2008;116(1):51-56.
29. Lee BK, Kim Y. Association of blood cadmium with hypertension in the Korean general population: analysis of the 2008-2010 Korean National Health and Nutrition Examination Survey data. Am J Ind Med. 2012;55(11):1060-7.
30. Navas-Acien A, Silbergeld EK, Sharrett R, Calderon-Aranda E, Selvin E, Guallar E. Metals in urine and peripheral arterial disease. Environ Health Perspect. 2005;113(2):164-9.