INTERNATIONAL SPINAL CORD INJURY DATA SETS

ENDOCRINE AND METABOLIC EXTENDED DATA SET (Version 1.0)

The working-group consists of:

William A. Bauman, chair, is a member of American Spinal Injury Association (ASIA). Jill M. Wecht, was an author on the International Standards to Document Remaining Autonomic Function after SCI and is a member of ASIA. Fin Biering-Sørensen, chair of the International Spinal Cord Injury Data Sets Committee under the International Spinal Cord Society (ISCoS) and ASIA, is a member of both ASIA and ISCoS.

The purpose of the International Spinal Cord Injury (SCI) Endocrine and Metabolic Extended Data Set is to standardize the collection and reporting of information on endocrine & metabolic function in accordance with the purpose and vision of the International SCI Data Sets (Biering-Sørensen, et al. 2006).

2012; Wecht, et al. 2011). When these specific disorders are clinically suspected specific components of this data set may be utilized to assist in diagnosis and treatment.

The information collected in this International SCI Endocrine and Metabolic Extended Data Set will generally be used in connection with data in the International SCI Core Data Set (DeVivo, et al. 2006), which includes information on date of birth and injury, gender, the cause of spinal cord lesion, and neurologic status. It will be used together with International SCI Endocrine and Metabolic Basic Data Set (Bauman, et al. 2011). In addition, it may be used together with other relevant International SCI Basic or Extended Data Sets, when appropriate and relevant. As an example, fragile fractures in SCI are described in the International SCI Musculoskeletal Basic Data Set (Biering-Sørensen, et al. 2012) and, therefore, this item was not included in the present dataset when collecting other variables related to osteoporosis of immobilization.

The diagnosis of endocrine and metabolic disorders has been clearly established in the general population. The direct application of this knowledge to persons with SCI can be accomplished by standard examination and laboratory determinations. The aim of this International SCI Endocrinology and Metabolism Extended Data Set is to present a standardized format for the collection and reporting of information on endocrine and metabolic disorders which have been identified in clinical practice and, after being collected, for possible research purposes. It may not be necessary in a particular patient to collect all variables provided in this data set; however, when a specific clinical issue, for example, hyperthyroidism is being assessed, it is recommended that all variables that are related to thyroid disease be collected. To permit valid comparison of information obtained, it is crucial that data be collected in a uniform manner. For this reason, each variable and each response category within each variable has specifically been defined in a way that is designed to promote the collection and reporting of comparable data. Use of a standard format is essential for combining data from multiple investigators and locations. Various formats and coding schemes may be equally effective and could be used in individual studies or by agreement of the collaborating investigators. The International SCI Endocrinology and Metabolism Extended Data Set will make it possible to evaluate and compare results from various published studies on endocrine and metabolic dysfunction after SCI, as an objective of the International SCI Data Sets.

The etiology of a spinal cord lesion may be traumatic or non-traumatic. All lesions to the spinal cord, conus medullaris, and cauda equina are included in the present context.

This document was produced under the auspices of ISCoS and ASIA.

Acknowledgement:
We are thankful for the comments and suggestions received from Lawrence Vogel, Eva Widerström-Noga, Susan Charlifue, Marcel Post, Peter New, Marcalee Sipski Alexander, Leslie Morse, Bill Leslie, and Niklas Rye Jørgensen. The authors wish to thank the Department of Veterans Affairs Rehabilitation Research and Development Service for their support (grant B4162C).
References


General remark regarding date of data collection/performing the test

DESCRIPTION: For each variable in this dataset the date of data collection/performing the test is required.

CODE YYYYMMDD (Year – Month – Day) Unknown

COMMENTS: Because the collection of data on endocrine and metabolic conditions may be performed at any time following the spinal cord lesion, the date of data collection is imperative for computing the time that has lapsed after the initial spinal cord lesion. This will permit the information obtained to be related to other data collected on the same individual at various time points.

CARBOHYDRATE METABOLISM

VARIABLE NAME: Fasting plasma glucose:

DESCRIPTION: This variable will assess the ability to maintain fasting glucose homeostasis

CODES: Fasting plasma glucose in mmol/L Date: YYYYMMDD; Unknown

COMMENTS: Classifications: Diabetes mellitus is diagnosed as a fasting glucose value ≥7 mmol/L (126 mg/dL); impaired glucose tolerance is defined as a fasting glucose value 5.6-6.9 mmol/L (100-125 mg/dL) (The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. 2003). An elevated fasting plasma glucose concentration would permit diagnosis of a disorder of oral carbohydrate tolerance. There is an increased prevalence of abnormalities in carbohydrate tolerance in persons with chronic SCI (Bauman, et al. 2002; Bauman, et al. 2001).

VARIABLE NAME: Oral carbohydrate tolerance – 2 hour plasma glucose:

DESCRIPTION: This variable will assess the ability to handle an oral glucose load.
Disorders of oral carbohydrate tolerance have been reported to be increased in persons with chronic SCI (Bauman, et al. 2002; Bauman, et al. 2001). Because disorders of oral carbohydrate tolerance often will remain occult unless provocative testing is performed, and because those with SCI have a increased prevalence of impaired glucose tolerance and diabetes mellitus, it is recommended that practitioners perform oral glucose tolerance testing at least once every 5 to 10 years, or if there is suspicion of deterioration in carbohydrate tolerance. Refer to the classification of The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus 2003.

VARIABLE NAME: Oral glucose tolerance test (OGTT) – diagnostic classification.

DESCRIPTION: This variable will assess the ability to handle an oral glucose load.

CODES: Normal; Impaired Glucose Tolerance; Diabetes Mellitus

COMMENTS: Classifications: Diabetes mellitus is diagnosed as a stimulated value (2 hours plasma glucose) ≥11.1 mmol/L (200 mg/dL); impaired glucose tolerance is defined as a stimulated value (2 hours plasma glucose) 7.8-10.9 mmol/L (140-199 mg/dL) (The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. 2003). Impaired glucose tolerance and type 2 diabetes mellitus are increased in persons with chronic SCI (Bauman, et al. 2002; Bauman, et al. 2001). Any disorder associated with hyperglycemia would be expected to increase the risk of cardiovascular disease. Diabetes mellitus is a cardiovascular risk equivalent in stratifying risk for appropriate therapeutic intervention (Haffner, et al. 1990; Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. 2001).

VARIABLE NAME: Fasting plasma insulin

DESCRIPTION: This variable will assess basal insulin reserve and peripheral insulin sensitivity.

CODES: Fasting plasma insulin in pmol/L
Date: YYYYYMMD; Unknown

COMMENTS: Normal range: fasting 35-105 pmol/L. As a consequence of
inactivity and adverse body compositional changes, persons with SCI have been found to be insulin resistant. The fasting plasma insulin level has been found to correlate with peripheral insulin sensitivity (Olesfsky, et al. 1973).

**VARIABLE NAME:** Oral carbohydrate tolerance – 2 hour plasma insulin

**DESCRIPTION:** This variable will assess insulin reserve and peripheral insulin sensitivity.

**CODES:** 2 hour plasma insulin in pmol/L
Date: YYYYMMDD; Unknown

**COMMENTS:** *Normal range:* stimulated <1076 pmol/L. Determinants of insulin resistance are strongly present in persons with SCI: decreased activity, decreased muscle mass, and increased absolute or relative adiposity. A strong correlation exists between the insulin response to an oral glucose load and peripheral insulin sensitivity/resistance (Olesfsky, et al. 1974).

**VARIABLE NAME:** Hemoglobin A1c (HgA1c)

**DESCRIPTION:** This variable documents average glycemic control.

**CODES:** HgA1c in %
Date: YYYYMMDD; Unknown

**COMMENTS:** *Normal value:* <6.5%. The integrated plasma glucose as reflected in the HgA1c value provides valuable information as to average carbohydrate handling.

**CALCIUM & BONE METABOLISM**

**VARIABLE NAME:** Plasma/Serum calcium concentration

**DESCRIPTION:** This variable documents abnormality in circulating total calcium level.

**CODES:** Plasma/Serum calcium concentration in mmol/L
Date: YYYYMMDD; Unknown
COMMENTS:  

**Normal range:** 2.2-2.6 mmol/L. Hypercalcemia during acute SCI may occur in individuals who have renal insufficiency (e.g., dehydration, acute or chronic renal disease) and/or high bone turnover rates (e.g., children, multiple bone fractures, Paget’s disease, or other conditions) (Maynard, et al. 1977; Bringhurst, et al. 1998), but hypercalcemia may also infrequently occur in adults with SCI without any predisposing conditions. Osteoporosis may result from paralysis and immobilization, but the skeletal loss may be made worse by a concomitant occult disorder in calcium metabolism. If the calcium concentration is elevated in an adult without a known pre-existing condition, it would suggest that another abnormality in calcium metabolism is present that may make the bone loss after SCI more pronounced. A high calcium concentration may suggest hyperparathyroidism and PTH-independent conditions (e.g., malignancy, vitamin D intoxication, granulomatous diseases, thiazides, etc.), whereas a low calcium value may suggest poor dietary intake of calcium and/or vitamin D deficiency.

**VARIABLE NAME:** Plasma ionized calcium concentration  
**DESCRIPTION:** This variable documents abnormality in circulating ionized calcium level.  
**CODES:** Plasma ionized calcium concentration in mmol/L  
Date: YYYYMMDD; Unknown  
**COMMENTS:**  

**Normal range:** 1.1-1.4 mmol/L. The free cation concentration in plasma is referred to as “ionized calcium.” Calcium is present in the blood in the protein-bound and free forms, which together comprise the total plasma calcium concentration. The total plasma calcium concentration may vary dependent predominantly upon the serum albumin concentration. Because the serum albumin concentration may vary because of acute or chronic illness, the plasma ionized calcium concentration provides a direct determination of the bioactive plasma calcium concentration (Baird. 2011). When there is uncertainty in the biologically active calcium concentration, often due to derangements in protein binding, it is recommended to perform a plasma ionized calcium concentration. Please refer to additional comments provided above for disorders in the plasma total calcium concentration that may occur in in persons with SCI.

**VARIABLE NAME:** 24-hour urinary calcium excretion  
**DESCRIPTION:** This variable documents renal excretion of calcium.
CODES: Urine calcium in mmol /24 hours
Date: YYYYMMDD; Unknown

COMMENTS: Normal range: <7.3 mmol/kg body weight. When the level of the plasma free calcium concentration is elevated or depressed, performing a 24-hour urinary calcium excretion will assist to clarify the clinical picture, and also provide information on the magnitude of the disorder. For example, shortly after SCI, there is an increase in bone resorption, which elevates the plasma ionized calcium concentration. This will result in increased renal excretion of calcium, with the magnitude of calcium excretion directly related to the degree of bone resorption. Hypercalciiuria may be associated renal lithiasis (Stewart, et al. 1982; Roberts, et al. 1998; Chen Y et al. 2000).

VARIABLE NAME: Spot urine calcium to creatinine ratio (Ca/Cr)
DESCRIPTION: This variable documents renal excretion of calcium.
CODES: Urine calcium (mmol) to creatinine ( μmol/L) ratio
Date: YYYYMMDD; Unknown

COMMENTS: Normal range: <0.057 mmol/μmol/L. Please refer to the comments on the variable entitled 24 hour urinary calcium excretion. In certain populations, such as children, a spot urine Ca/Cr is often more practical to obtain than a 24-hour urine collection for calcium measurement. To exclude absorptive hypercalciemia, it is recommended that the spot urine Ca/Cr be performed after an oral calcium load. Although a linear correlation has been reported between a fasting first-morning spot urine Ca/Cr and 24-hour urine collection for calcium measurement (Reusz, et al. 1995), other reports have suggested a weak correlation between fasting or non-fasting spot urine Ca/Cr collection and 24-hour urine collection for calcium measurement (Koyun, et al. 2007; Alconcher, et al. 1997). As such, a 24-hour urinary calcium excretion is the preferred test to more definitively establish the diagnosis of hypercalciuria.

VARIABLE NAME: Serum vitamin 25-hydroxyvitamin D (25-OH D) level
DESCRIPTION: This variable documents low or normal body stores of vitamin D
CODES: 25-OH D level in nmol/L
Date: YYYYMMDD; Unknown
COMMENTS: Normal range: 50-150 nmol/L. Persons with SCI have been identified to have a greater prevalence of being vitamin D deficient (Bauman, et al. 1995). Measuring the level of 25-OH D, the storage form of vitamin D, is accepted as the routine manner to exclude a vitamin D deficient state. A deficiency of vitamin D would reduce gut absorption of calcium and predispose to osteoporosis. Adequate intake and circulating levels of vitamin D are important to maintain skeletal integrity (Bauman, et al. 1995; Binkley, et al. 1983). There exists controversy as to the acceptable lower limit of vitamin D concentration. The Thirteenth Workshop Consensus for Vitamin D Nutritional Guidelines (Norman, et al. 2007) and the Institute of Medicine (Institute of Medicine of the National Academies. 2011) recommended a serum 25-OH D concentration of ≥50 nmol/L; this value for 25-OH D was chosen for the general population primarily because of a lack of solid evidence provided by prospective controlled clinical trials to support the benefits of the higher threshold value, and because of potential adverse effects of higher 25-OH D values. The prior recommendations being appreciated, the Endocrine Society recommended a slightly higher lower limit of normal for serum 25-OH D concentration of ≥75 nmol/L (Holick et al., 2011) because of the patient subpopulation referred to endocrinologists for care, considerations based on calcium metabolism (Heaney et al.; Dawson-Hughes et al.), and variation in 25-OH D assay standardization and reproducibility. Because persons with SCI have severe sublesional osteoporosis, often have reduced calcium intake, and have a tendency for low 25-OH D levels for a variety of reasons (Bauman, et al. 1995), setting the lower limit for 25-OH D at ≥75 nmol/L in this population seems reasonable.

VARIABLE NAME: Plasma parathyroid hormone (PTH) level
DESCRIPTION: This variable documents the level of parathyroid gland function.
CODES: Plasma PTH level in ng/L
Date: YYYYMMDD; Unknown
COMMENTS: Normal range: 10-65 ng/L. Elevation in the plasma PTH often cause excessive bone loss. If plasma PTH is elevated, it may worsen the bone loss associated with SCI. Secondary hyperparathyroidism may occur in persons with SCI due to vitamin D deficiency and/or reduced vitamin D levels (Bauman, et al. 1995).

VARIABLE NAME: Plasma/Serum N-telopeptide (NTX) concentration
**DESCRIPTION:**
This variable documents the level of bone resorption.

**CODES:**
Plasma/Serum NTX in nmol bone collagen equivalent (BCE)
Date: YYYYMMDD; Unknown

**COMMENTS:**
*Normal range for men:* 8.1-24.8 nmol BCE; *normal range for women:* 7.7-19.3 nmol BCE. This test should be performed on an early morning blood collection. The measurement of specific degradation products of the bone matrix (e.g., metabolic markers of bone resorption and formation) provide analytical information concerning bone turnover (Delmas, 1993). Because of diurnal variation in the values for biochemical bone markers, early morning sample collection is recommended for plasma/serum NTX, as well as for all other circulating bone markers. Increased osteoclast activity occurs soon after SCI and causes heightened bone resorption (Chantraine, et al. 1986; Pietschmann, et al. 1992; Roberts, et al. 1998). The level of bone resorption may be determined by measuring biochemical markers of the bone matrix in the circulation. NTX is the N-terminal of the telopeptide of type 1 collagen, which is released during collagen degradation and has been used as a biochemical marker of bone resorption.

**VARIABLE NAME:** Spot urine N-telopeptide (NTX) concentration

**DESCRIPTION:**
This variable documents the level of bone resorption.

**CODES:**
Urine NTX in nmol bone collagen equivalent (BCE)/mmol creatinine;
Date: YYYYMMDD; Unknown

**COMMENTS:**
*Normal range in adults:* Males: 13-78 nmol BCE/mmol creatinine; Females: 14-74 nmol BCE/mmol creatinine. Please refer to the comments on the parameter entitled plasma/serum NTX. This test should be performed early in the morning on a urine second void collection. The level of bone resorption may be measured by determining the urinary excretion of NTX.

**VARIABLE NAME:** Plasma/Serum C-terminal telopeptide (CTX) concentration

**DESCRIPTION:**
This variable documents the level of bone resorption.
CODES: Plasma/Serum CTX in ng/L
    Date: YYYYMMDD; Unknown

COMMENTS: Normal range in adults: Males: 18-29 years = 90–1200 ng/L, 30-49 years = 70-800 ng/L, 50-68 years = 90–350 ng/L, >68 years = not established; Females 18-29 years = 60–650 ng/L, 30-49 years = 40–460 ng/L; 50-68 years = not established, >68 years = not established. This test should be performed on an early morning blood collection. Please refer to the general comments on the variable entitled N-telopeptide concentration. CTX is the C-terminal of the telopeptide of type 1 collagen, which is released during collagen degradation, has been used as a biochemical marker of bone resorption. Because of diurnal variation in the values for biochemical bone markers, early morning sample collection is recommended for plasma/serum CTX.

VARIABLE NAME: Plasma/Serum osteocalcin concentration
DESCRIPTION: This variable documents the level of bone formation.

CODES: Plasma/Serum osteocalcin in µg/L
    Date: YYYYMMDD; Unknown

COMMENTS: Normal range in adults: 1.7-25 µg/L. This test should be performed on an early morning blood collection. Please refer to the general comments on the variable entitled N-telopeptide concentration. Increased osteoblast activity may occur immediately after SCI and it reflects increased bone turnover. The level of bone formation may be determined by measuring biochemical markers of the bone matrix in the circulation. Osteocalcin is a small non-collagenous protein that is synthesized by osteoblasts. Because of diurnal variation in the values for biochemical bone markers, early morning sample collection is recommended for plasma/serum osteocalcin.

VARIABLE NAME: Plasma/Serum procollagen type 1 N-terminal extension peptide (P1NP)
DESCRIPTION: This variable documents the level of bone formation.

CODES: Plasma/Serum P1NP in µg/L
    Date: YYYYMMDD; Unknown

COMMENTS: Normal range in adults: Males: 30-110 µg/L; Females: 20-106 µg/L. This test should be performed on an early morning blood collection. Please refer to the general comments on the variable entitled
plasma/serum osteocalcin. PINP is derived from procollagen, which is cleaved to form type 1 collagen from the N-terminal propeptide. Because of diurnal variation in the values for biochemical bone markers, early morning sample collection is recommended for plasma/serum PINP.

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Dual energy x-ray absorptiometry for bone mineral density (BMD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable documents bone mineral density at skeletal sites of interest, including the distal femur, proximal tibia, total hip, femoral neck, and radius (at one-third site).</td>
</tr>
<tr>
<td>CODES:</td>
<td>Region of skeleton osteoporotic: knee, hip, and radius: If osteoporosis is present for persons ≥50 years old, place an “X” in the space provided:</td>
</tr>
<tr>
<td></td>
<td>Total Hip ___ (-2.5 or less SD) Femoral neck ___ (-2.5 or less SD)</td>
</tr>
<tr>
<td></td>
<td>Total Hip ___ (g/cm²) Femoral neck ___ g/cm²)</td>
</tr>
<tr>
<td></td>
<td>Radius (33%) ___ (-2.5 or less SD) Radius (33%) ___ g/cm²)</td>
</tr>
<tr>
<td></td>
<td>If Z-values are below the expected range for age for persons &lt;50 years old, place an “X” in the space provided:</td>
</tr>
<tr>
<td></td>
<td>Hip _____ (-2.0 or less SD) Radius _____ (-2.0 or less SD)</td>
</tr>
<tr>
<td></td>
<td>BMD for the knee:</td>
</tr>
<tr>
<td></td>
<td>Distal femur and Proximal tibia in g/cm²</td>
</tr>
<tr>
<td>DATE:</td>
<td>YYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>Osteoporosis: In men and women age 50 or older, a T-score at or below -2.5 SD permits the diagnosis of osteoporosis.</td>
</tr>
<tr>
<td></td>
<td>Determination of bone loss in men younger than 50 years of age and in pre-menopausal women: The Z-score should be employed to assess bone loss; a Z-score ≤-2.0 is defined as below the expected range for age (Note: the diagnosis of osteoporosis cannot be made using the Z-score.) T-scores and Z-scores have not available for the distal femur and proximal tibia; as such, absolute scores for BMD of these regions of interest should be obtained. For consistency, the recommendation is to use the NHANES III database (without the manufacturer’s proprietary database as well) for each patient, who would then have their scores matched to this reference data base by age, gender and ethnicity. If serial scans are to be acquired in following potential bone loss, it would be important to standardize scans by their boney dimensions. At this time, only one company (GE Lunar) has FDA approved software specifically to acquire the knee in the adult, but other companies have adapted other software packages for this purpose as well. If the regions of interest (ROI) are meticulously obtained, then the results should be comparable</td>
</tr>
</tbody>
</table>
regardless of the software employed to obtain the ROI. Immobilization results in bone loss, dependent upon the degree of inactivity and its duration (Biering-Sørensen, et al. 1990; Doty, et al. 1995). Persons with more complete motor SCI who have the greatest neurological impairments and the most extreme degrees of physical immobilization would be expected to have the most rapid and marked bone loss, which appears to be progressive with the duration of injury (Bauman, et al. 1999; Eser, et al. 2004). The long-bone strength, and hence the risk of fractures, is related to bone mass and bone quality/microarchitecture (Ammann, et al. 2003; Fonseca, et al. 2014).

**THYROID FUNCTION**

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Thyroid gland size</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable permits a clinical evaluation of thyroid status.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Goiter: absent; present</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>The size of the thyroid gland permits a clinical evaluation of its functional integrity. An enlarged thyroid gland; weight: &gt;20 g estimated by palpation; volume: &gt;17 cm$^3$ by sonogram measurement (Ng, et al 2004) may be the result of a functional disorder (either hyperthyroidism or hypothyroidism).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Plasma/Serum thyroid stimulating hormone (TSH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable permits an evaluation of thyroid status.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Plasma/Serum TSH in mU/L</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td><em>Normal range</em>: 0.5-5 mU/L. TSH measurement permits a biochemical evaluation of function of the thyroid gland. An elevated TSH value would be consistent with hypothyroidism, whereas a suppressed value would suggest hyperthyroidism. The sensitive TSH assay is often a component of routine blood panels but, if not, should be performed if there is clinical evidence of either hyper- (heat intolerance, excess sweating, unexplained weight loss, tachycardia, etc.) or hypo-activity (cold intolerance, dry skin, unexplained weight gain, bradycardia, etc.) of the thyroid gland.</td>
</tr>
<tr>
<td>VARIABLE NAME:</td>
<td>Description:</td>
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<tr>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Plasma/Serum triiodothyronine (T&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>This variable permits an evaluation of thyroid status.</td>
</tr>
</tbody>
</table>
| **CODES:** | Plasma/Serum T<sub>3</sub> in nmol/L  
Date: YYYYMMDD; Unknown |
| **COMMENTS:** | Normal range: 1.1-2.9 nmol/L. T<sub>3</sub> or T<sub>4</sub> are hormones released by the thyroid gland, and their measurement permits a biochemical evaluation of the function of this gland. The plasma-serum T<sub>3</sub> determination may be a component of routine blood panels but, if not, should be performed if there is clinical evidence of a thyroid disorder. An elevated T<sub>3</sub> value would be consistent with hyperthyroidism, whereas a low value would suggest hypothyroidism. |

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum thyroxine (T&lt;sub&gt;4&lt;/sub&gt;)</td>
<td>This variable permits an evaluation of thyroid status.</td>
</tr>
</tbody>
</table>
| **CODES:** | Serum T<sub>4</sub> in nmol/L  
Date: YYYYMMDD; Unknown |
| **COMMENTS:** | Normal range: 64-154 nmol/L. Refer to comments on T<sub>3</sub>. The plasma-serum T<sub>4</sub> determination may be a component of routine blood panels but, if not, should be performed if there is clinical evidence of a thyroid disorder. An elevated serum T<sub>4</sub> value would be consistent with hyperthyroidism, whereas a low value would suggest hypothyroidism. |

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum T&lt;sub&gt;3&lt;/sub&gt; resin uptake (T&lt;sub&gt;3&lt;/sub&gt;RU)</td>
<td>This variable permits an evaluation of thyroid hormone protein binding, as well as status of thyroid function.</td>
</tr>
</tbody>
</table>
| **CODES:** | Serum T<sub>3</sub>RU  
Date: YYYYMMDD; Unknown |
| **COMMENTS:** | Normal range: 0.25-0.35. The T<sub>3</sub>RU is a traditional means to indirectly estimate the free T<sub>3</sub> hormone concentration. In a competitive binding manner, radiolabeled thyroid hormone competes with endogenous, or unlabeled thyroid hormone, to bind to a solid- |
phase matrix coated with T₃ antibody; the binding to the matrix is determined by the unoccupied T₃ binding sites (i.e., level of thyroid binding globulin) and the unlabeled, or endogenous, T₃. An elevated serum T₄RU value would be consistent with high thyroid hormone binding availability (i.e., increased thyroid binding globulin and/or hypothyroidism), whereas a low value would suggest low thyroid hormone binding availability (i.e., decreased thyroid binding globulin and/or hyperthyroidism).

**VARIABLE NAME:** Thyroid antibodies

**DESCRIPTION:** This variable permits determination of an autoimmune thyroid condition.

**CODES:** Thyroid antibodies: absent; present
Date: YYYYMMDD; Unknown

**COMMENTS:** If one or more anti-thyroid antibodies is determined to be present (i.e., anti-thyroglobulin, anti-thyroid peroxidase, and/or anti-TSH receptor), the presence of such antibodies will be recorded. The determination of thyroid antibodies should be performed if there is clinical evidence of a thyroid disorder that is not explained by other etiologies. Stress has been described to precipitate autoimmune thyroid disease in predisposed individuals (Sonino, et al. 1993). In the general population, autoimmune thyroid disease is highly prevalent, with women disproportionately affected. As many as 50% of people in the community have microscopic nodules, 3.5% have occult papillary carcinoma, 15% have palpable goiters, 10% demonstrate an abnormal thyroid-stimulating hormone level, and 5% of women have overt hypothyroidism or hyperthyroidism (Wang, et al. 1997). In the general population, thyroid antibodies are usually present and detectable in the presence of autoimmune disease, and there is no reason to assume otherwise in those with SCI.

**VARIABLE NAME:** Thyroid disease

**DESCRIPTION:** This variable documents the presence of known thyroid disease.

**CODES:** Thyroid disease: absent; present
Date of disease diagnosed: YYYYMMDD; Unknown

**COMMENTS:** Pituitary-hypothalamic insult at time of acute SCI, or in the immediate aftermath, should be considered. At the time of acute injury, in the absence of thyroid disease, thyroid function tests may
be abnormal due to the stress of the event, intercurrent illness, and/or
However, it should be noted that stress has been described to
precipitate thyroid disease in predisposed individuals (Sonino, et al.
1993). In the general population, autoimmune thyroid disease is
highly prevalent, with women disproportionally affected; thyroid
antibodies are usually present and detectable.

VARIABLE NAME: Thyroid disease: diagnostic classification
DESCRIPTION: This variable identifies the specific diagnosis of thyroid disease.
CODES: Diagnosis
COMMENTS: Diagnoses: Graves’ disease, Hashimoto’s disease, diffuse nontoxic
goiter, nontoxic multinodular goiter, toxic multinodular goiter, acute
thyroiditis, subacute thyroiditis, thyroid cancer, hyperfunctioning
thyroid nodule, hypofunctioning thyroid nodule. Refer to the above
comments on thyroid disease.

VARIABLE NAME: Morning serum cortisol level
DESCRIPTION: This variable documents adrenal function.
CODES: 06-08 (a.m.) fasting serum cortisol level in nmol/L
       Date: YYYYMMDD; Unknown
COMMENTS: Normal range: 140-690 nmol/L. Of note: During periods of stress,
a “normal” serum cortisol level would be inappropriately low and
suggest a deficiency state. Several of the symptoms of adrenal
insufficiency may be found in persons with SCI, including
weakness, gastrointestinal disorders, hypotension, and syncope. As
such, a high index of suspicion for the diagnosis should be
entertained. Pre-existing adrenal insufficiency can be a life-
threatening event in the setting of catastrophic illness. Although
uncommon, abdominal injury/surgery may predispose to
hemorrhage and necrosis of the adrenal glands, and/or central
nervous system injury, especially with more severe injury, and may
result in hypothalamic stalk and/or pituitary compromise (Klose, et
al. 2007; Sinelnikov, et al. 2007). Because of the catastrophic event
of acute injury and the ever present potential for associated
stressful events in the acute and subacute periods after injury, including hemorrhage, major organ damage, emergent and/or elective surgery, sepsis, coagulopathy, hypotensive and/or hypertensive crises, it is imperative to consider adrenal insufficiency at time of presentation after acute injury and until full medical stabilization (Siu, et al. 1990). Although less commonly prescribed than in the past, the administration of high-dose methylprednisolone in an effort to reduce acute neurological injury may be associated with adrenal suppression, which may present as intractable hypotension, related to, or independent of, an intercurrent catastrophic event (Lecamwasam, et al. 2004). Even in the absence of antecedent glucocorticoid administration, persons with acute SCI may have adrenal insufficiency (Pastrana, et al. 2012). In those with chronic SCI, adrenal circadian rhythm and function has been shown to be generally normal (Zeitzer et al. 2000), but stimulation tests to determine adrenal reserve have shown abnormalities in functional capacity (Huang et al. 1997; Wang et al. 1999).

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>24-hour urinary cortisol level</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable documents adrenal function.</td>
</tr>
<tr>
<td>CODES:</td>
<td>24-hour urine cortisol in nmol/24 hours</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>Normal range: 55-276 nmol/24 hours. Of note: During periods of stress, a “normal” 24-hour urine cortisol excretion would be inappropriately low and suggest a deficiency state. Refer to above comment on serum cortisol level.</td>
</tr>
</tbody>
</table>

GONADAL FUNCTION

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Testicular size (men only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable documents anatomical abnormality of the testes.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Testis: normal size; small</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td>Normal adult size testes: 3.5-5.5 cm in length; gonadal size to be determined by an ordinary ruler, an orchidometer, or ultrasonography (Taskinen, et al. 1996). Examination of the testes is</td>
</tr>
</tbody>
</table>
an essential part of the evaluation of testicular function. Because age
does not influence testicular size per se, documenting small testes is
a significant finding, regardless of the individual’s age. Post-pubertal
damage to the testes may result in small, soft testes. Thus, the
absence of small testes would suggest the absence of significant
damage to the seminiferous tubules (i.e., end-organ injury).

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Plasma/Serum testosterone concentration <em>(men only)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable documents testicular function.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Plasma/Serum testosterone value in nmol/L</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
</tbody>
</table>
| COMMENTS:     | Normal range for men: 10-35 nmol/L. Because the serum
testosterone concentration has a diurnal variation and falls
throughout the day, it is recommended that levels be drawn early in
the morning (Brambilla, et al. 2009). Testosterone deficiency in the
general population has been shown to occur in about 30% of men
aged 40-79 years, with its prevalence increasing with more advanced
age (Allan, et al. 2004; Gray, et al. 1991). In persons with SCI, the
prevalence of testosterone deficiency is significantly greater
(Bauman, et al. 2014). Clinical symptoms of testosterone deficiency
include fatigue, decreased libido, erectile dysfunction, and negative
Testosterone has beneficial effects on body composition,
specifically to maintain muscle mass and strength, as well as to
of testosterone replacement therapy in men shown to be deficient
may be considered (Bhasin, et al. 2009). More recently interest has
focused on the metabolic abnormalities that may be increasingly
prevalent with testosterone deficiency, including type 2 diabetes
mellitus, hypertension, and coronary artery disease (Zmuda, et al.

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Serum sex hormone binding globulin (SHBG) <em>(men only)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable permits the determination of free sex steroids</td>
</tr>
<tr>
<td>CODES:</td>
<td>Serum sex hormone binding globulin in nmol/L</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
</tbody>
</table>
COMMENTS: Normal range: 9.5-65.0 nmol/L (for men). Hormones that are insoluble in water require carrier mechanisms: transport proteins. The transport proteins function as reservoirs, with the hormones being in dynamic equilibrium of being bound or free, with a small fraction of free hormone in the circulation. Only the free hormone enters cells and has biological activity. Sex hormones (e.g. testosterone and estrogen) are weakly bound to albumin (~60%) and more tightly bound to a circulating binding protein, SHBG (~40%). The free and non-SHBG hormone concentrations, often referred to as “bioactive” testosterone concentration, can be calculated from the total testosterone concentration, serum albumin concentration, and SHBG value (Vermeulen, et al. 1999).

VARIABLE NAME: Serum albumin (men only)
DESCRIPTION: This variable permits the determination of serum albumin
CODES: Serum albumin in µmol/L
Date: YYYYMMDD; Unknown
COMMENTS: Normal range: 540-740 µmol/L
Please refer to the comments on the parameter entitled serum SHBG. Albumin weakly binds hormones that are transported in the circulation. The free and “bioactive” hormone concentrations can be calculated from the total serum sex steroid concentration, serum albumin concentration, and SHBG value (Vermeulen, et al. 1999).

VARIABLE NAME: Serum bioactive testosterone (men only)
DESCRIPTION: This variable permits the determination of bioactive testosterone
CODES: Serum bioactive testosterone in pmol/L
Date: YYYYMMDD; Unknown
COMMENTS: Normal range: 2,600-17,600 pmol/L (for men). Serum bioactive testosterone represents the fraction of circulating total testosterone that is either free or loosely bound to albumin (~60% of total testosterone concentration). Because the serum testosterone concentration has a diurnal variation and falls throughout the day, it is recommended that levels be drawn early in the morning (Brambilla, et al. 2009). The bioactive testosterone is hypothesized to be the more active components of total testosterone. The free and “bioactive” hormone concentrations can be calculated from the total
serum sex steroid concentration, serum albumin concentration, and SHBG value (Vermeulen, et al. 1999).

**VARIABLE NAME:** Serum free testosterone *(men only)*

**DESCRIPTION:** This variable permits the determination of free testosterone

**CODES:** Serum free testosterone in pmol/L  
Date: YYYYMMDD; Unknown

**COMMENTS:** *Normal range: 113-750 pmol/L (for men).* Serum free testosterone represents the fraction of circulating total testosterone that is not bound to SHBG or albumin (~2% of total testosterone concentration). Because the serum testosterone concentration has a diurnal variation and falls throughout the day, it is recommended that levels be drawn early in the morning (Brambilla, et al. 2009). The free testosterone is hypothesized to be the most active component of total testosterone. The free and “bioactive” hormone concentrations can be calculated from the total serum sex steroid concentration, serum albumin concentration, and SHBG value (Vermeulen, et al. 1999).

**VARIABLE NAME:** Plasma/Serum estradiol concentration *(women only)*

**DESCRIPTION:** This variable documents ovarian hormonal function.

**CODES:** Plasma/Serum estradiol in pmol/L  
Date: YYYYMMDD; Unknown

**COMMENTS:** *Normal range women: basal: 70-220 pmol/L; ovulatory surge: >740 pmol/L; post menopausal: 40> pmol/L.* Estradiol concentrations reflect the integrity of ovarian sex hormone production, which also reflects the function of the hypothalamic-pituitary axis to release gonadotropins in an appropriate manner.

**PITUITARY FUNCTION**

**VARIABLE NAME:** Plasma prolactin concentration

**DESCRIPTION:** This variable documents hypothalamic-pituitary dopaminergic tone.
CODES: Plasma prolactin in mmol/L
Date: YYYYMMDD; Unknown

COMMENTS: Normal range men & non-pregnant women: 39-102 mmol/L. Plasma prolactin concentrations increase in the presence of reduced dopaminergic tone. It has been suggested that persons with chronic SCI have a dysfunction of central dopaminergic tone that may affect pituitary prolactin release, with a subset of persons with chronic SCI having elevated prolactin concentrations basally and a larger subset after provocative stimulation (Huang. 1996).

VARIABLE NAME: Plasma luteinizing hormone (LH) concentration
DESCRIPTION: This variable documents pituitary gonadotropic function.
CODES: Plasma LH in IU/L
Date: YYYYMMDD; Unknown

COMMENTS: Normal range for men: 1.3-13 IU/L. The effects of SCI on sexual organs and function generally have different clinical courses in men and woman. Pituitary-hypothalamic insult at time of acute SCI, or in the immediate aftermath, should be considered. In men with chronic SCI, reports have appeared to suggest that testosterone levels are depressed, with abnormalities of the pituitary-hypothalamic regulation of the gonads (Huang, et al. 1996; Kostovski, et al. 2008). Normal range for women: basal: 0.8-26; ovulatory surge: 25-57; (time of menstrual cycle to be determined by clinical assessment using subjective information); postmenopausal: 40-104 IU/L. The effects of SCI on sexual organs and function generally have different clinical courses in men and woman. Although menses may be temporarily interrupted at time of acute injury, the menstrual cycle usually returns thereafter, with full capacity to conceive (Sipski. 1991).

VARIABLE NAME: Plasma follicular stimulating hormone (FSH) concentration
DESCRIPTION: This variable documents pituitary gonadotropic function.
CODES: Plasma FSH in IU/L
Date: YYYYMMDD; Unknown

COMMENTS: Normal range for men: 0.9-15 IU/L. Normal range for women: basal: 1.4-9.6; ovulatory surge: 2.3-21; postmenopausal: 34-96 IU/L.
<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Plasma insulin-like growth factor-1 (IGF-1).</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable will permit evaluation of integrated plasma growth hormone concentrations.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Plasma IGF-1 in kU/L</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td><em>Normal range for men:</em> 0.34-2.2 kU/L. <em>Normal range for women:</em> 0.45-1.9 kU/L. Pituitary-hypothalamic dysfunction may occur in persons with SCI at time of acute SCI or may develop years afterward. The response of growth hormone to provocative stimulation has been shown to be blunted in persons with SCI. Plasma insulin-like growth factor, in the absence of liver disease, provides an estimate of integrated daily growth hormone release (Bauman, et al. 1994).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE NAME:</th>
<th>Plasma copeptin</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION:</td>
<td>This variable reflects the secretion of vasopressin by the posterior pituitary.</td>
</tr>
<tr>
<td>CODES:</td>
<td>Plasma copeptin (pmol/L)</td>
</tr>
<tr>
<td></td>
<td>Date: YYYYMMDD; Unknown</td>
</tr>
<tr>
<td>COMMENTS:</td>
<td><em>Normal range:</em> 1.7-11.25 pmol/L</td>
</tr>
<tr>
<td></td>
<td>Central diabetes insipidus results from the inability to secrete vasopressin to appropriately concentrate the urine. If there is clinical suspicion for diabetes insipidus, which would include a hyperosmolar state (e.g., hypernatremia) in association with a relatively dilute urine, a plasma copeptin level should be considered. Vasopressin secretion is pulsatile and its residence time in the circulation is low. As such, the measurement of copeptin, the C-terminal portion of pre-provasopressin (i.e., a peptide secreted in equimolar amounts to vasopressin) affords a practical alternative to measurement of vasopressin (Morgenthaler, et al. 2013; Dobsa, et al. 2013). If during fluid restriction the serum copeptin concentration does not increase, and/or the serum sodium concentration is elevated in the presence of dilute (hypo-osmolar) urine, a dysfunction of vasopressin release from the posterior pituitary may be present. A fluid deprivation test with DDAVP should be considered.</td>
</tr>
</tbody>
</table>
VARIABLE NAME: Fluid deprivation test with desmopressin (DDAVP).

DESCRIPTION: This variable permits evaluation for diabetes insipidus.

CODES: Fluid deprivation test: Positive or Negative
Date: YYYYMMDD; Unknown

COMMENTS: Normal response: >50% in urine osmolarity (positive test)
Posterior pituitary dysfunction may occur in persons with SCI at time of acute SCI, or may develop years afterward (Farrell CA et al. 1986; Closson, et al., 1993; Kuzevli, et al. 2001). Head trauma not infrequently occurs with SCI, with as high as 60% of those with traumatic SCI also sustaining a TBI (Maccoiuchi et al., 2008), and 2% of cases of head trauma cases have been reported to be associated with diabetes insipidus (Leroy, et al. 2013). If there is a central deficiency of vasopressin (also known as antidiuretic hormone), then there will be difficulty in concentrating the urine (<300 mosmol/L) and an increase in urine volume (>50 ml/kg). If there is clinical suspicion for diabetes insipidus, which would include a hyperosmolar state (e.g., hypernatremia) in association with urine which is relatively dilute, a fluid deprivation test should be considered. After ad libitum fluid intake, fluid intake is restricted (usually in the morning) until urine concentration increases to >300 mosmol/L or increases to a specific gravity >1.010. However, before the body weight decreases by 5% during fluid restriction, and if the urine does not concentrate and the plasma osmolarity and/or serum sodium concentration exceed the upper limit of normal, then intravenous or subcutaneous desmopressin (DDAVP, 0.03 ug/kg) should be administered with the urine osmolarity measured 1 to 2 hours later. If the urine concentrates sufficiently after DDAVP administration, then central DI is diagnosed; if the urine does not concentrate after DDAVP, renal resistance to DDAVP is to be considered.

SYMPATHETIC NERVOUS SYSTEM FUNCTION

VARIABLE NAME: Plasma norepinephrine (NE)

DESCRIPTION: This variable documents the integrity of the sympathetic nervous system.

CODES: Plasma NE supine in nmol/L
Date: YYYYMMDD; Unknown
Plasma NE seated/standing in nmol/L
Date: YYYYMMDD; Unknown
COMMENTS: Normal range: supine = 0.74-1.41 nmol/L; seated/standing = 1.68-2.44 nmol/L. Impairment of autonomic (e.g., sympathetic nervous system) integrity will compromise the ability to maintain blood pressure with upright posture due to absence of a vasopressor response (Claydon VE, et al. 2006; Krassioukov, A et al. 2006). NE is a neurotransmitter released by post-synaptic sympathetic neurons, which binds to the vascular walls, causing peripheral vasoconstriction, thereby opposing hemodynamic fluid shifts to the dependent circulation during upright positioning. Inadequate post-synaptic NE release results in hemodynamic instability and orthostatic hypotension. Levels of plasma NE are low in individuals with cervical SCI in the supine resting position (0.40 nmol/L) (Mathias, et al. 1975; Sahota, et al. 2012) and upright positions (0.75 nmol/L) (Mathias, et al. 1975). In individuals with a higher cord lesion who appear to have difficulty in maintaining blood pressure with upright positioning, partial or total ablation of the sympathetic response should be considered, which may be reflected by resting supine levels below 0.56 nmol/L and an attenuated plasma NE response to head-up tilt (Mathias, et al. 1975; Sahota, et al. 2012).

RENIN-ALDOSTERONE AXIS FUNCTION

VARIABLE NAME: Plasma renin activity (PRA)

DESCRIPTION: This variable documents the integrity of one component of the renal response to hypotension.

CODES:
Plasma renin supine in µg/L/h
Date: YYYYMMDD; Unknown
Plasma renin seated/standing in µg/L/h
Date: YYYYMMDD; Unknown

COMMENTS: Normal range: supine = 3.2±1 µg/L/h; seated/standing = 9.3±4.3 µg/L/h. Elevated PRA is reported in individuals with cervical SCI in the supine position (2.5 µg/L/h) and in response to head-up tilt (12.7 µg/L/h) (Mathias, et al. 1975; Mathias, et al. 1980). Normal salt and water metabolism is essential for maintenance of cardiovascular homeostasis. With a fall in blood pressure, the renin-aldosterone system is activated (Marik, et al. 2008; Mathias, et al. 1975; Mathias, et al. 1980). In the presence of renal insufficiency, a deficient plasma renin response will result in impaired renal retention of salt and water due to the inability to appropriately stimulate aldosterone release from the adrenal cortex.
VARIABLE NAME: Serum aldosterone

DESCRIPTION: This variable documents the integrity of one component of the adrenal cortical response to hypotension.

CODES:
- Serum aldosterone supine in pmol/L
  Date: YYYYMMDD; Unknown
- Serum aldosterone seated/standing in pmol/L
  Date: YYYYMMDD; Unknown

COMMENTS: Normal range (normal diet): supine = <240 pmol/L; seated/standing = 140-560 pmol/L. Serum aldosterone concentrations are within the normal range in individuals with cervical SCI in the supine position (228 pmol/L), but heightened serum aldosterone responses to head-up tilt have been reported (700 pmol/L) (Mathias, et al. 1975; Mathias, et al. 1980). Appropriate regulation of salt and water metabolism to upright posture by activation of the renin-aldosterone system is essential for maintenance of cardiovascular homeostasis (Marik, et al. 2008; Mathias, et al. 1975). A deficient serum aldosterone response to upright posture will result in impaired hemodynamic regulation due to the inability to appropriately retain salt and water by the kidney.
Appendix  INTERNATIONAL SPINAL CORD INJURY DATA SETS

INTERNATIONAL SPINAL CORD INJURY ENDOCRINOLOGY AND METABOLISM
EXTENDED DATA SET — DATA FORM (Version 1.0)

Carbohydrate Metabolism:
Plasma glucose:
- Fasting _____ mmol/L; Date YYYYMMDD; ☐ Unknown
- 2 hours _____ mmol/L; Date YYYYMMDD; ☐ Unknown
OGTT diagnostic classification: ☐ normal; ☐ Impaired Glucose Tolerance; ☐ Diabetes Mellitus

Plasma insulin:
- Fasting _____ pmol/L; Date YYYYMMDD; ☐ Unknown
- 2 hours _____ pmol/L; Date YYYYMMDD; ☐ Unknown

Hemoglobin A1c: ______________% ; Date YYYYMMDD; ☐ Unknown

Calcium & Bone Metabolism:
Plasma/Serum calcium _____ mmol/L; Date YYYYMMDD; ☐ Unknown
Plasma ionized calcium _____ mmol/L Date YYYYMMDD; ☐ Unknown
Urine calcium _____ mmol/24 hours; Date YYYYMMDD; ☐ Unknown
Urine calcium/creatinine _____ mmol/mg; Date YYYYMMDD; ☐ Unknown
Serum 25-OH D: ___ nmol/L; Date YYYYMMDD; ☐ Unknown
Plasma parathyroid hormone (PTH) level: ___ ng/L; Date YYYYMMDD; ☐ Unknown

Plasma/Serum N-telopeptide _____ nmol BCE; Date YYYYMMDD; ☐ Unknown
Urine N-telopeptide __________ nmol BCE/mmol creat; Date YYYYMMDD; ☐ Unknown
Plasma/Serum C-telopeptide _______ ng/L; Date YYYYMMDD; ☐ Unknown
Plasma/Serum osteocalcin __________ μg/L; Date YYYYMMDD; ☐ Unknown
Plasma/Serum P1NP________ μg/L; Date YYYYMMDD; ☐ Unknown

Dual energy x-ray absorptiometry: Date YYYYMMDD; ☐ Unknown
If osteoporosis (-2.5 or less SD) is present for persons ≥50 years old, place an “X” in the space provided for each skeletal site of interest:
- Total Hip _____ Femoral neck _____ Radius _____
Bone mineral density (BMD) for each the skeletal sites of interest:
- Total Hip _______ (g/cm²)
- Femoral neck _______ (g/cm²)
- Distal femur _______ (g/cm²)
- Proximal tibia _____ (g/cm²)
- Radius _____ _____ (g/cm²)

If Z-values are below the expected range for age for persons <50 years old, place an “X” in the space provided:
- Hip _____ (-2.0 or less SD) Radius _____ (-2.0 or less SD)
Thyroid Function:
Goiter: ☐ absent ☐ present; Date YYYYMMD; ☐ Unknown
Plasma/Serum thyroid stimulating hormone (TSH) _____ mU/L; Date YYYYMMD; ☐ Unknown
Plasma/Serum triiodothyronine (T3) ________nmol/L Date YYYYMMD; ☐ Unknown
Serum thyroxine (T4) ________nmol/L Date YYYYMMD; ☐ Unknown
Serum T3 resin uptake (T3RU) ________ Date YYYYMMD; ☐ Unknown
Thyroid antibodies: ☐ absent ☐ present; Date YYYYMMD; ☐ Unknown
Thyroid disease: ☐ absent ☐ present; Date disease diagnosed YYYYMMD; ☐ Unknown
Thyroid diagnosis _______________________

Adrenal Function:
06-08 (a.m.) fasting serum cortisol _____ nmol/L; Date YYYYMMD; ☐ Unknown
24-hour urine cortisol _____ nmol/24 hours; Date YYYYMMD; ☐ Unknown

Gonadal Function:
Men:
Testis ☐ normal size ☐ small; Date YYYYMMD; ☐ Unknown
Plasma/Serum testosterone _____ nmol/L; Date YYYYMMD; ☐ Unknown
Serum sex hormone binding globulin _____ nmol/L Date YYYYMMD; ☐ Unknown
Serum albumin _____ µmol/L Date YYYYMMD; ☐ Unknown
Serum bioactive testosterone _____ pmol/L Date YYYYMMD; ☐ Unknown
Serum free testosterone _____ pmol/L Date YYYYMMD; ☐ Unknown
Women:
Plasma/Serum estradiol _____ pmol/L; Date YYYYMMD; ☐ Unknown

Pituitary Function:
Anterior Pituitary:
Plasma Prolactin _____ nmol/L; Date YYYYMMD; ☐ Unknown

Men:
Plasma luteinizing hormone (LH) _____ IU/L; Date YYYYMMD; ☐ Unknown
Plasma follicular stimulating hormone (FSH) _____ IU/L; Date YYYYMMD; ☐ Unknown
Plasma insulin-like growth factor-1 (IGF-1) (baseline) _____ kU/L; Date YYYYMMD; ☐ Unknown

Women:
Plasma LH _____ IU/L; Date YYYYMMD; ☐ Unknown
Plasma FSH _____ IU/L; Date YYYYMMD; ☐ Unknown
Identify the time of menstrual cycle (basal, ovulatory surge, postmenopausal) ________________
Plasma IGF-1 (baseline) _____ kU/L; Date YYYYMMD; ☐ Unknown

Posterior Pituitary:
Plasma copeptin _____ pmol/L; Date YYYYMMD; ☐ Unknown
Fluid deprivation test with DDAVP ☐ positive ☐ negative Date YYYYMMD; ☐ Unknown

Sympathetic Nervous System Function:
Plasma norepinephrine supine _____ nmol/L Date YYYYMMD; ☐ Unknown
Plasma norepinephrine seated/standing _____ nmol/L Date YYYYMMD; ☐ Unknown
Renin-Aldosterone Axis Function:
Plasma renin supine ______ μg/L/h
Plasma renin seated/standing ______ μg/L/h
Serum aldosterone supine ______ pmol/L
Serum aldosterone seated/standing ______ pmol/L

Conversion Factor (CF) × Conventional (C) = System of International Units (SI)

Glucose 0.05551 × mg/dL = mmol/L
Insulin 7.175 × µU/mL = pmol/L
Total Calcium (plasma) 0.2595 × mg/dL = mmol/L
25-Hydroxycholecalciferol (25-OH-D) 2.496 × ng/dL = nmol/L
Cortisol 27.59 × µg/dL = nmol/L
Testosterone 4.467 × ng/mL = nmol/L
Estradiol 3.671 x pg/ml = pmol/L
Creatinine 88.4 x mg/dL = μmol/L
Other conversions:
pg/mL = ng/L
ng/mL = µg /L
µU/mL = mU/L
mU/mL = U/L
U/mL = kU/L