DCPAH Liver Mineral Reference Ranges

Reference range values for liver mineral concentrations reported by DCPAH were determined based on data accumulated in our laboratory by ICP/MS analysis between 2009 and 2014. The total database included 10,000 samples, which for reference range development were subdivided by species. In addition, for those species where sufficient numbers of samples from fetal or neonatal tissue were available, a separate reference range was developed for fetal and neonatal samples.

This database in no way represents a planned random sampling of normal animals, such as might be ideal for reference range development. However, we believe the reference ranges developed from this database are useful and provide a valuable “frame of reference” for interpretation of our results. We make this conclusion after examining liver mineral concentrations as described in numerous research reports based on experiments in which animals were receiving diets of known adequate mineral concentrations.

Median liver mineral concentrations from such studies are within the reference ranges constructed from our database, suggesting the vast majority of the samples we analyze are from animals that have adequate mineral nutriure and are not suffering from mineral or heavy metal intoxications. In any cases in which results from controlled research trials did not support our reference ranges, the reference ranges were adjusted to better agree with the controlled data.

Percentiles, rather than standard deviations, were used to define the reference ranges, because in most cases the data did not follow a normal distribution pattern. The reference ranges represent the interval from the 10th to the 90th percentile of the database, with a few exceptions based on the availability of controlled data. This defines the interval between the “L” (low) and “H” (high) flags. We interpret values within this reference range as being adequate with respect to nutritional minerals and nontoxic with respect to heavy metals or other toxic minerals. “Adequate” in this regard means there is no reason to expect that increasing the dietary intake of a specific mineral will result in any discernable clinical response in the patient.

Critical values, as indicated by the “@” flag, were initially chosen as those below the 2.5th percentile (critical low) or above the 97.5th percentile (critical high). These values were modified in those cases where clear evidence from pathological studies had indicated an appropriate deficient or toxic range. Patients with values flagged as critical are considered at high risk for clinical deficiency or intoxication.
Dry Weight vs. Wet Weight

Mineral values and reference ranges for both Minerals, Tissue and Minerals, Fixed Tissue (50254 and 50255) are reported on a dry tissue basis. The dry weight fraction, except for small biopsy samples, is calculated individually for each tissue sample received. Therefore, to convert the value reported above to an “as received” or wet weight basis, simply multiply the value by the dry weight fraction. The wet-tissue mineral concentration will always be a smaller number than the dry tissue value. Values converted in this manner may be used directly in comparison with any published reference ranges that are based on wet tissue values.

For small samples, such as those taken as percutaneous or laparoscopic biopsies, there is a high probability of partial desiccation during shipping. Thus, any calculation of wet tissue mineral concentrations for such samples could be subject to substantial error. Therefore, the samples are dried completely prior to analysis and no attempt is made to determine the dry matter fraction. In those cases, a dry matter fraction of 1.0 is reported in the table of results. The wet tissue mineral concentration for such biopsy samples cannot be calculated exactly. It may, however, be reasonably estimated by multiplying the sample mineral concentration by the average value of the dry weight fraction reference range.

A reference range for the dry matter fraction is listed in the table of results. Dry matter fraction values below the reference range are unusual, but could potentially represent over hydration of the patient, or shifts in body water compartments due to electrolyte abnormalities. Dry matter fractions above the reference are not unusual and may represent either dehydration of the patient or fatty infiltration of the tissue. In the case of fatty tissue, particularly liver or kidney, interpretation of the tissue mineral concentrations is affected.