H4 Year-of-Death Determination Based Upon the Measurement of Atomic Bomb-Derived Radiocarbon in Human Soft Tissues

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After attending this presentation, attendees will understand how above-ground nuclear testing in the 1950s and early 1960s dramatically increased environmental levels of radiocarbon. These elevated levels have been incorporated into all organisms living since that time and thus can serve as temporal markers. Potentially, radiocarbon measurements of postmortem human tissues can be used forensically to establish Year-of-Birth and/or Year-of-Death. One advantage of this approach is that it functions independently of chemical or biological methods for the determination of Postmortem Interval, or Age-at-Death, and thus might augment current methods for establishing these parameters.

This presentation will impact the forensic community by providing data to assess the method's ability to predict Year-of-Death based upon soft tissue radiocarbon levels. The study quantifies precision and accuracy when applied to soft tissues from 36 known-age/known year- of-death human remains.

Environmental levels of radiocarbon spiked upwards from 1955 to 1963 due to above-ground nuclear testing and have been descending back towards natural levels ever since. It enters human tissues through diet; and growth and normal metabolic tissue replacement leads to the continuous incorporation of radiocarbon throughout life. Replacement rates vary between different tissues and so radiocarbon is unevenly distributed within the various tissue compartments of late 20^{th}/early 21^{st} century humans. Moreover, the distribution of radiocarbon in a specific individual is related to when he or she lived and died relative to the atmospheric radiocarbon spike and so the phenomenon has potential forensic applications. This particular study hypothesized that tissues with high replacement rates should have radiocarbon levels closest to the contemporary environment. Therefore, postmortem measurement of radiocarbon levels within such tissues should mark the Year-of-Death.

Radiocarbon levels were determined in blood, hair, nails, skin collagen, skin lipid, and bone lipid obtained from 36 individuals deceased in 2006. Levels were found to be lowest in blood, hair and nail samples and progressively increased in skin lipid, bone lipid, and skin collagen. Variation in radiocarbon levels within a tissue type was found to be surprisingly low, perhaps reflecting similarities in the diet of the sample population. Significantly, the magnitude of variation within the tissue populations was similar to the magnitude of the variation found in direct atmospheric radiocarbon measurements. Together, these observations allowed estimation of the method's precision. The best case measurement precision based upon fingernail radiocarbon measurements was a two sigma uncertainty of ± 2.5 years. However, precision varied considerably between tissues and is sensitive to death year. The accuracy of the method could not be quantified due to limitations of the published atmospheric radiocarbon data sets, however this is relatively straightforward to overcome.

This study is the most comprehensive empirical investigation of Year-of-Death estimation based upon tissue radiocarbon measurements to date. The method shows promise, however a broader study is necessary. Measurements of carbon and nitrogen stable isotopes in bone collagen purified from the study population indicated a surprising homogeneity in diet. This fact might have generated a spurious overestimation of the method's precision. Certain diets can alter tissue radiocarbon levels so it must be determined whether the observed dietary homogeneity was a quirk of the sample population or if it reflects widely shared behaviors. A second caveat is that published data on atmospheric radiocarbon levels extends only to 2003. Thus the present study estimated contemporary levels by extrapolation. Clearly the way forward is to expand the cultural and geographic diversity of test population and extend the reference data sets of atmospheric radiocarbon measurements up to the present.

Radiocarbon, Year-of-Death, Human Tissues