

OSAC RESEARCH NEEDS ASSESSMENT FORM



Title of research need: Antemortem Skeletal Injury, Bone Repair, and Estimation of Time Since Injury

Describe the need:

Estimation of Time Since Injury (TSI) in skeletal trauma analysis is often critical for adjudication of pediatric suspected non-accidental injury (NAI) cases. It can also be important for identifying patterned elderly abuse. Yet estimation of TSI has been described as an “inexact science”—no validated methods exist in forensic anthropology or pathology for its accurate estimation. While considerable progress has been made in terms of our understanding of histological and radiological (e.g., Capella and Cattaneo 2019; Capella et al. 2019) signatures of bone repair, validated methods for TSI estimation represent a critical need in forensic skeletal trauma research and practice.

Keyword(s): Antemortem Skeletal Injury; Time Since Injury; Bone Repair

Submitting subcommittee(s): Anthropology **Date Approved:** 9/19/2025

Background Information:

1. Does this research need address a gap(s) in a current or planned standard? (ex.: Field identification system for on scene opioid detection and confirmation)

ASB Standard 147 (Standard for Analyzing Skeletal Trauma in Forensic Anthropology) establishes minimum requirements for skeletal trauma analysis for forensic anthropology practitioners. It stresses that trauma analysis “shall be...analyzed using available peer-reviewed, published methods, standards, or best practices” and cautions that trauma analysis shall be limited to descriptions (rather than interpretations) when evidence is lacking (thus, reducing its utility in court testimony). It does not provide detailed recommendations for estimation of trauma timing. Although there are several published peer-reviewed publications on the process and timing of bone repair, particularly in infants, few incorporate methods for interpreting TSI, and none of these methods have been validated.

2. Are you aware of any ongoing research that may address this research need that has not yet been published (e.g., research presented in conference proceedings, studies that you or a colleague have participated in but have yet to be published)?

Boyd, D.C. 2025 The scientific foundation for skeletal trauma analysis. In: Boyd, D. C., Sochor, M. (eds): *Forensic Skeletal Trauma: Scientific Foundation and Guide to Professional Practice*. Sussex, UK: Wiley Publishers, in association with the American Academy of Forensic Sciences *Forensic Science in Focus* series.

Messer, D., Boyd, D. 2025 Pediatric Fracture Healing in Cases of Suspected and Non-Accidental Trauma: Clinical, Radiographic, Anthropological, and Histological Perspectives. Workshop to be presented at the 2025 annual meeting of the American Academy of Forensic Sciences, Baltimore, MD.

3. Key bibliographic references relating to this research need: (ex.: Toll, L., Standifer, K. M., Massotte, D., eds. (2019). Current Topics in Opioid Research. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-88963-180-3)

Butler, J., Iyer, H., Press, R., Taylor, M., Vallone, P., Willis, S. (2020), NIST Scientific Foundation Reviews, NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], <https://doi.org/10.6028/NIST.IR.8225> (Accessed November 26, 2024).

Capella, A., Cattaneo, C. 2019. Exiting the limbo of perimortem trauma: a brief review of microscopic markers of hemorrhaging and early healing signs of bone. Forensic Science International, 302.

Capella, A., De Boer, H. H., Cammilli, P., De Angelis, D. Messina, C., Sconfienza, L. M., Sardenelli F., Sforza C. 2019. Histologic and radiological analysis on bone fractures: estimation of posttraumatic survival time in skeletal trauma. Forensic Science International, 302.

Fleischman, J. M., Vollner, J., Adams, B., Crowder, C. M., Pinto, D., Soto Martinez, M., Rainwater, C., Vogelsberg, C., Wiersema, J. 2023. The evolving role of forensic anthropologists in medical examiner's offices. Forensic Anthropology DOI: 10.5744/fa.2023.0013.

Isaac, C. V., Sony, R., Devota, C. J., Vanbaarle, A. L., Ross, A. Deep learning models for fracture detection and segmentation in bone histology. American Academy of Forensic Sciences, 2024 Denver CO.

Sanchez TR et al. Retrospective evaluation and dating of non-accidental rib fractures in infants. Clin Radiol. 2013; 68(8):467-71.

Klotzbach et al. Post-mortem diagnosis and age estimation of infants' fractures. Int J Legal Med. 2003; 117(2):82-9.

Kleinman PK, et al. Radiologic contributions to the investigation and prosecution of cases of fatal infant abuse. N Engl J Med. 1989; 320(8):507-11.

Malone, C. A., Sauer, N. J., Fenton, T. W. 2011. A radiographic assessment of pediatric fracture healing and Time Since Injury. Journal of Forensic Sciences, 56, 1123-1130.

Naqvi A et al. Histological ageing of fractures in infants: a practical algorithm for assessing infants suspected of accidental or non-accidental injury. Histopathology 2019; 75: 74-80.

4. Review the annual operational/research needs published by the National Institute of Justice (NIJ) at <https://nij.ojp.gov/topics/articles/forensic-science-research-and-development-technology-working-group-operational#latest>? Is your research need identified by NIJ?

Yes, in part. This research need falls under the broad topic of "Further research on bone healing rates, at the macro- and micro-levels, and the quantification of healing rate differences by age of individual and by skeletal element," which is listed as applicable to both Forensic Anthropology and Forensic Pathology disciplines. However, the NIJ topic area does not specifically indicate the need for validated methods for Time Since Injury estimation, which are likely to be derived from a combination of quantified healing rates and other data.

5. In what ways would the research results improve current laboratory capabilities?

A large portion of casework for many forensic anthropology practitioners centers on trauma consults (Fleischman et al. 2023), with many focused on evaluation of pediatric (and elderly) suspected abuse, yet validated methods for estimation of TSI in skeletal trauma analysis are lacking. Developing validated research methods will greatly improve the accuracy, precision, repeatability, and reproducibility of TSI estimations conducted in professional laboratories and will allow identification of bias and error in current methods and procedures.

6. In what ways would the research results improve understanding of the scientific basis for the subcommittee(s)?

This research will improve our understanding of bone repair, its timing, and the many intrinsic and extrinsic factors that affect it. Following recommendations from the National Commission on Forensic Science (2016) for evaluating scientific research, NIST's Scientific Foundation Reviews (Butler et al. 2020) delineate criteria for the scientific validity of forensic disciplines. This includes methodology that is clear and based on reproducible (e.g., controlled experimental) procedures that are appropriate to the question or problem and that have been or have the capacity to be fully and rigorously validated. Validated methods are those that are based on accurate, precise, repeatable (consistent results over time and by different operators), and reproducible (e.g., consistent results from other laboratories) procedures, including methods that measure and document measurement uncertainty and bias.

7. In what ways would the research results improve services to the criminal justice system?

Skeletal trauma analysis, particularly casework involving pediatric NAI, is the most frequent reason for forensic anthropologists' involvement in court testimony. Knowledge of accuracy, precision, reliability, and bias associated with estimations of TSI in trauma cases will strengthen the scientific accuracy of results for these cases, help adjudicate them, and address standards for admissibility of this evidence.

8. Status assessment (I, II, III, or IV):

	I		Major gap in current knowledge	Minor gap in current knowledge
		No or limited current research is being conducted	I	III
		Existing current research is being conducted	II	IV

This research need has been identified by one or more subcommittees of OSAC and is being provided as an informational resource to the community.