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Describing Visible Acute Injuries: Development of a Comprehensive Taxonomy for Research and Practice

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Abstract

BACKGROUND—Little literature exists classifying and comprehensively describing intentional and unintentional acute injuries, which would be valuable for research and practice. In preparation for a study of injury patterns in elder abuse, our goal was to develop a comprehensive taxonomy of relevant types and characteristics of visible acute injuries and evaluate it in geriatric patients.

METHODS—We conducted an exhaustive review of the medical and forensic literature focusing on injury types, descriptions, patterns, and analyses. We then prepared iteratively, through consensus with a multi-disciplinary, national panel of elder abuse experts, a comprehensive classification system to describe these injuries.

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Statement of Contributorship

All authors made substantial contributions to the research within this manuscript. These contributions were:

- Study concept and design: Rosen, Reisig, LoFaso, Bloemen, Clark, Flomenbaum, Lachs
- Development of preliminary version of taxonomy: Rosen, Reisig, LoFaso, Bloemen
- Revision of taxonomy through consensus: Rosen, Reisig, LoFaso, Bloemen, Clark, Mtui, Flomenbaum, Lachs
- Recruitment of expert panel: Rosen, Lachs
- Incorporation of comments/suggestions/recommended changes from expert panel: Rosen, Reisig, LoFaso, Bloemen, Clark, McCarthy, Mtui, Flomenbaum, Lachs.
- Pilot testing of taxonomy: Rosen, Reisig, LoFaso, Bloemen
- Post-pilot testing of taxonomy: Rosen, LoFaso, Bloemen, McCarthy
- Initial drafting of manuscript: Rosen, Reisig
- Revision of manuscript critically for important intellectual content: LoFaso, Bloemen, Clark, Mtui, McCarthy, Flomenbaum, Lachs
- Study supervision: Rosen, LoFaso, Clark, Mtui, Flomenbaum, Lachs

RESULTS—We designed a 3-step process to fully describe and classify visible acute injuries: (1) determining the type of injury, (2) assigning values to each of the characteristics common to all geriatric injuries, and (3) assigning values to additional characteristics relevant for specific injuries. We identified 9 unique types of visible injury and 7 characteristics critical to describe all these injuries, including body region(s) and precise anatomic location(s). For each injury type, we identified 2–7 additional critical characteristics, such as size, shape, and cleanliness. We pilot-tested it on 323 injuries on 83 physical elder abuse victims and 45 unintentional fall victims from our ongoing research to ensure that it would allow for the complete and accurate description of the full spectrum of visible injuries encountered and made modifications and refinements based on this experience. We then used the classification system to evaluate 947 injuries on 80 physical elder abuse victims and 195 unintentional fall victims to assess its practical utility.

CONCLUSIONS—Our comprehensive injury taxonomy systematically integrates and expands on existing forensic and clinical research. This new classification system may help standardize description of acute injuries and patterns among clinicians and researchers.

Keywords

Coding Systems; Scale development; Methodology; Older People; Elder abuse

Introduction

A comprehensive classification system for acute visible injuries would be valuable to standardize research and forensics. Development of a system may also improve completeness and accuracy of documentation of injuries in clinical practice, which may be particularly useful for health care providers in tracking wound healing and for the medico-legal assessment of assault.

Coding systems for traumatic injuries exist that focus on severity as well as general anatomic location, and physiology,[1,2] and organ-specific classification systems have been developed for acute internal injuries.[3] Classification systems and standardized data elements have been proposed for individual types of visible injury, such as skin tears.[4–8] To our knowledge, however, there are no comprehensive published taxonomies for use in research, forensics, or clinical practice that include multiple types of visible injury and describe the precise anatomic location of the injury. We believe developing such a taxonomy is necessary to successfully conduct our injury research.

Our research group explores injuries in physical elder abuse with the goal of identifying patterns diagnostic of abuse and giving clinicians tools to differentiate between intentional and unintentional geriatric injuries. While most injuries in older adults are unintentional, including falls,[9–12] a significant number are intentional,[13,14] including many that result from elder abuse or neglect.[15–18] Elder abuse is common[15–17,19–21] and has serious health consequences,[22–31] but it is under-recognized and under-reported.[16,17,32] As assessment by health care providers may represent the only contact outside the family for many older adults, clinicians have a unique opportunity to diagnose suspected elder abuse and initiate intervention.[13,22,23,33–36] Despite this, physicians seldom report elder abuse.[37] Among the most important reasons for poor reporting is the difficulty in distinguishing between elder

abuse and the sequelae of accidental trauma.[38–42] Identifying pathognomonic evidence-based injury patterns that should not occur from an accident, such as metaphyseal fractures and bruising not over bony prominences, is the cornerstone of detecting child abuse,[43–56] which clinicians do commonly. Though more challenging because of the normal physiologic changes that occur with aging[38–42] and the use of chronic medications such as those that may affect bleeding and bone strength, similar systematic research is critically needed[57] to inform elder abuse detection, with the goal of identifying pathognomonic injury patterns. To conduct this research and develop tools to assist clinicians in differentiating between intentional and unintentional injury patterns, our work relies on complete and accurate description of all injuries.

Given the critical role of such a classification system in our research and its potential broad utility,[58] our goal was: to develop a comprehensive taxonomy of relevant types and characteristics of visible acute injuries and to evaluate it in geriatric patients.

Methods

Initial Literature Review

We conducted an exhaustive, non-systematic literature review to identify any existing injury classification systems or taxonomies in the medical and forensic literature. We also reviewed descriptions of injury types and patterns, with a focus on injury characteristics. We used the MEDLINE and Scopus databases, with keyword “injury” AND “types,” “patterns,” “characteristics,” “classification,” “taxonomy,” or “forensics” from 1960 to present. We also conducted general internet searches using Google and Google Scholar using the search terms described above. All searches were conducted in June-August 2014. We focused on elder abuse, child abuse, and intimate partner violence literature to gain a broad perspective on documentation of intentional injuries. We also manually reviewed existing forensics and injury epidemiology textbooks. We used a similar literature review strategy in developing a novel protocol for photographing injuries in the acute care setting.[59] Though we were unable to identify any existing comprehensive classification systems in our review, we did find literature that informed the development of our taxonomy.

Synthesis/Development

Several authors (TR, CR,VL, EB) collaboratively synthesized information from this literature review to develop the preliminary framework of our classification system. Two of these authors, Drs. Rosen, an emergency physician, and LoFaso, a geriatrician, have forensic experience, serving on the New York City Elder Fatality Review Team in collaboration with members of the New York City Medical Examiner’s Office, the NYC Department of Health, law enforcement, and prosecutors. Drs. Rosen and LoFaso also serve as the physician members on multi-disciplinary elder abuse teams in Manhattan and Brooklyn. After finalizing a list of unique injury types, we conducted additional literature searches for each type to identify critical descriptive characteristics and any existing classification systems. For these searches, we also used Medline and Scopus databases, Google and Google Scholar, and forensic and injury epidemiology textbooks. This initial version of the taxonomy was presented to anatomist co-author EM, who recommended changes to the

body regions and precise locations, which were incorporated. Other co-authors reviewed the taxonomy in detail during several meetings, and recommended changes were discussed and adopted through consensus.

Incorporation of Input from Expert Panel

The taxonomy was then presented to a national multi-disciplinary panel of experts in elder abuse and injury research for their input. The experts who participated in the review of this taxonomy were all members of a multi-disciplinary group of leaders elder abuse and injury research who convene several times annually to review, critique, and provide feedback to research colleagues about work in progress. Panelists were recruited to participate in the synthesis/development phase of this classification system through e-mail and telephone correspondence. The expert panel included multiple physician and social work researchers as well as are several epidemiologists and statisticians with expertise in measurement strategies. On the panel was physician researcher and a social worker with extensive forensic experience. The critiques and recommendations of these experts were made during conference calls and meetings, discussed until consensus was reached, and incorporated.

Pilot Evaluation and Refinement

Before finalizing the classification system, we pilot-tested it on 323 injuries on 83 physical elder abuse victims and 45 unintentional fall victims from our ongoing research to ensure that it would allow for the complete and accurate description of the full spectrum of visible injuries encountered. This ongoing research examines injuries in physical elder abuse victims using photographs, medical records, and police records from legal files of successfully prosecuted cases through a partnership with a large urban district attorney's office. Geriatric fall victims were enrolled prospectively on presentation to a large, urban, academic medical center Emergency Department. Photographs of all injuries were taken using a standardized protocol[59] and medical records were reviewed. Private screening was performed at intake including elements of the previously validated Elder Abuse Suspicion Index[60] to ensure that fall victims were not actually elder abuse victims. This research was reviewed and approved by the ____ Institutional Review Board. Injury classification using the taxonomy during this pilot was conducted by authors TR, CR, VL, and EB. After the pilot, we made additional modifications and refinements through consensus among co-authors. These changes have included: allowing a single injury to span multiple body regions, expanding the list of precise locations to increase the ability to describe injuries on the face, and adding additional options for shapes of several injury types.

Assessment of Practical Utility

After this pilot phase, the classification system has been used to evaluate an additional 947 injuries on 80 physical elder abuse victims and 195 unintentional fall victims to assess its practical utility. We found that multiple authors (TR, VL, EB, and TM) were able to use the taxonomy to fully characterize these injuries without additional modifications to the taxonomy needed. Future work will include formal assessment of validity and inter-rater reliability in using the classification to evaluate injuries. Also, future development and evaluation of this taxonomy may include involvement of medical examiners or other forensic pathologists.

Comprehensive Classification System

Overview

We designed a 3-step process to fully describe and classify visible acute injuries (Figure 1). This process includes: (1) determining the type of injury, (2) assigning values to each of the characteristics common to all geriatric injuries, and (3) assigning values to additional characteristics relevant for specific injuries.

Injury Types

We identified 9 unique types of visible injury (Figure 1). We have included injuries previously described only in highly specialized forensic literature, such as traumatic alopecia.[38,61–63] We have not included gunshot wounds,[64,65] fractures, dislocations, traumatic tooth loss, or internal injuries. Though clinically important types of acute injury and sometimes visible, these injuries are largely internal, and detailed classification systems have been developed for each.[3,64–67] We also did not include decubitus ulcerations. While these injuries may be important clinical markers of elder neglect,[68], they typically develop over a period of time rather than after acute injury, and there are existing classification systems for these wounds.[69]

Characteristics for All Visible Injuries

We identified 7 characteristics critical for the description of all visible geriatric injuries, including: body region(s) and precise location(s), as well as intent, mechanism of injury, implement causing injury, and timing of injury as reported by the patient and other source(s) (see Figure 1). We included the anatomic location of all injuries, categorizing these locations into six body regions (skull/brain, maxillofacial/dental/neck, thorax (chest)/abdomen/back, pelvis/gluteal region, upper extremities, lower extremities) based on previous literature.[41] To allow for more precise description of the location of the injury, we identified 247 precise locations within the six body regions. This categorization was based on a review of existing literature[70–73] and consultation with an anatomist (EPM). As an example, precise locations for the maxillofacial/dental/neck region are shown in Figure 2. In our classification system, each injury may span multiple body regions and precise locations. Notably, to appropriately describe injury location in a standard fashion and avoid confusion, we recommend that the patient's body is envisioned to be in anatomic position and that "ulnar" and "radial" are used when possible to describe location in the upper extremity. Ambiguity is created if body positioning is not specified, particularly in the upper extremity. For example, previous studies of bruising patterns in physical elder abuse, reported increased bruising to the "lateral" right arm among elder abuse victims, suggesting that this might represent a defensive injury.[74] The location on the arm they are likely describing is the ulnar aspect, which is actually medial rather than lateral in anatomic position.

Critical Additional Characteristics for Specific Injury Types

For each injury type, we identified 2–7 additional critical characteristics and a list of options for each characteristic by synthesizing existing literature: bruises,[48,49,74–80] soft tissue swelling,[62,79,81] abrasions,[78,79,82–84] lacerations,[70,73,78,79,83,84] burns,[78,79,83–86] skin

tears,[4–8] puncture/stab wounds,[78,79,83,84] bites,[87–89] and traumatic alopecia.[38,61–63] Though some previous researchers have included soft tissue swelling without discoloration within bruises,[90] we have included these as distinct types of injuries because of differing views in the existing literature.[62,81] Notably, though research has suggested that color is unreliable to determine age of a bruise,[76] we included it as a characteristic in this taxonomy because of the frequency with which color has been used historically and that it may have clinical significance in identifying multiple episodes of violence. Examples of critical additional characteristics and potential options for each characteristic are shown for bruises (Figure 3) and burns (Figure 4). Figures 1–4 are excerpts from the classification system used as examples. The entire taxonomy is available as online supplementary material and on xxx.com.

Pain without Evidence of Injury

Our comprehensive taxonomy also allows for the inclusion of "pain without evidence of injury" resulting from trauma. This allows for the patient's report of pain without visible injury resulting from the trauma in any part of their body to be documented for analysis using the precise locations described above. This category may be particularly important for body areas which are less prone to show signs of injury, such as the neck and other parts of the body not overlying bony prominences, and for forensic and research evaluation of injury patterns.

Conclusion/Future Directions

This comprehensive taxonomy to describe visible acute injuries, which systematically integrates and expands on existing forensic and clinical research, has been tested on a geriatric population and proven useful. This new classification system may help standardize the description of visible injuries and patterns among researchers, forensic specialists, and clinicians. Our work may supplement existing coding and classification systems for internal injuries including fractures. Notably, Koin proposed a forensic medical examination form to improve clinician documentation of suspected elder abuse.[91] We believe that our taxonomy significantly expands and improves on this work by adding body regions and precise locations as well as other injury characteristics, which allow for more standardized and accurate description of all visible injuries, facilitating comparative research. We have designed a database to allow the information from this injury classification system to be easily captured and continue to actively using it in our research to improve understanding of injury patterns in elder abuse. Future directions include formal assessment of validity and inter-rater reliability and involving medical examiners or other forensic pathologists in the project. Also, we believe that this classification system may be connected to existing coding systems such as the International Classification of Diseases, Tenth Revision (ICD-10) to expand its utility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Messages

What is Already Known

- Little literature exists that describes classification and comprehensive description of intentional and unintentional geriatric injuries.
- A comprehensive classification system for geriatric injuries would be valuable for research and practice

What this Study Adds

- We have designed a comprehensive taxonomy to fully describe and classify visible acute geriatric injuries
- This taxonomy systematically integrates and expands on existing forensic and clinical research and may help standardize the description of geriatric injuries and patterns among clinicians and researchers

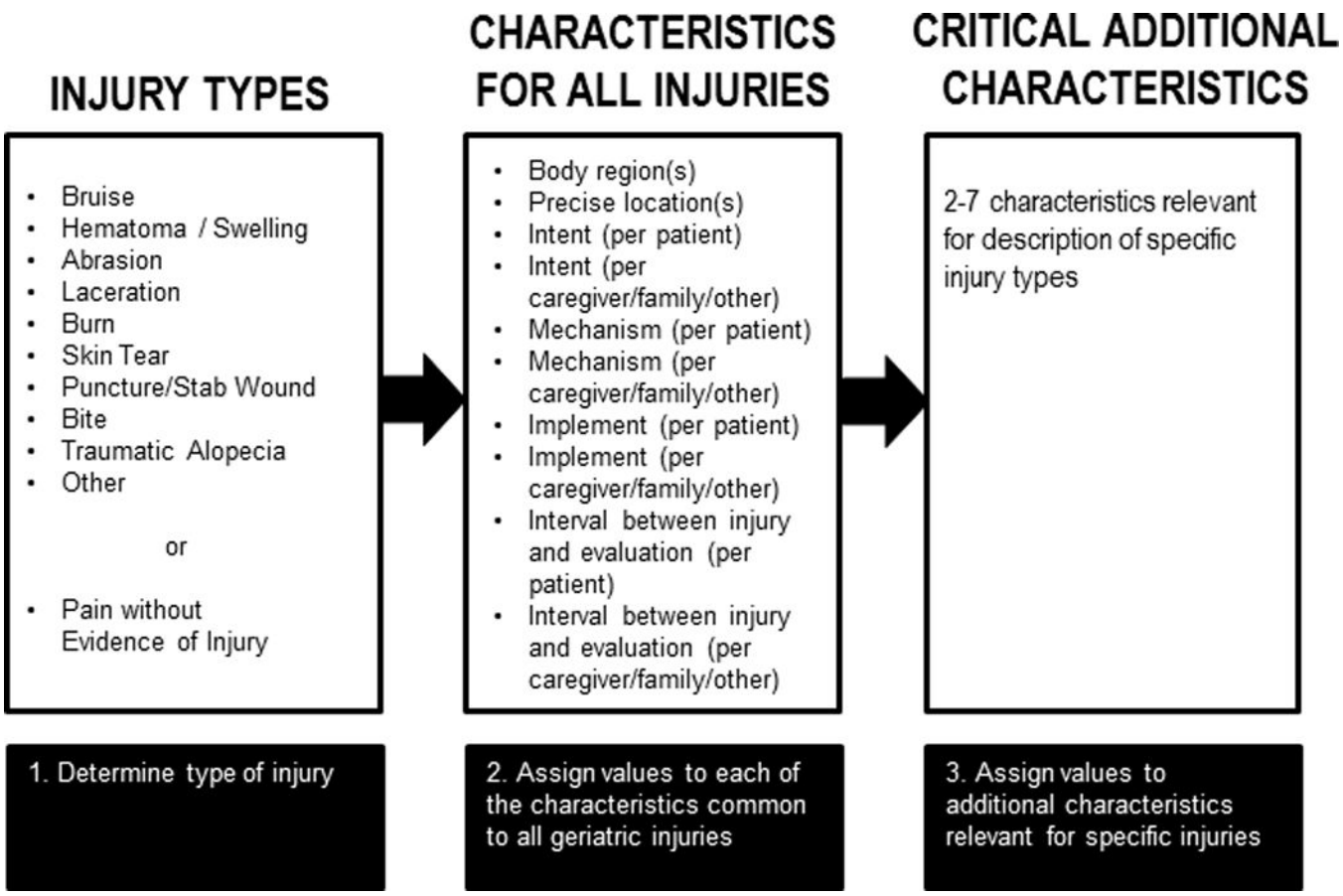

Figure 1.
Overview of 3-step process for classification of visible acute injuries

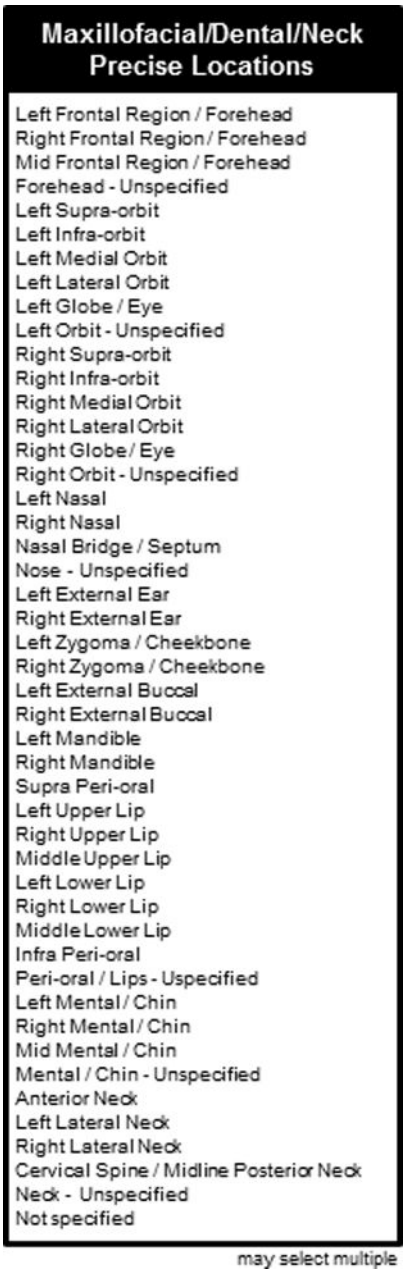

Figure 2.

Options for precise surface anatomical location in classification of visible acute injuries within the maxillofacial/dental/neck body region

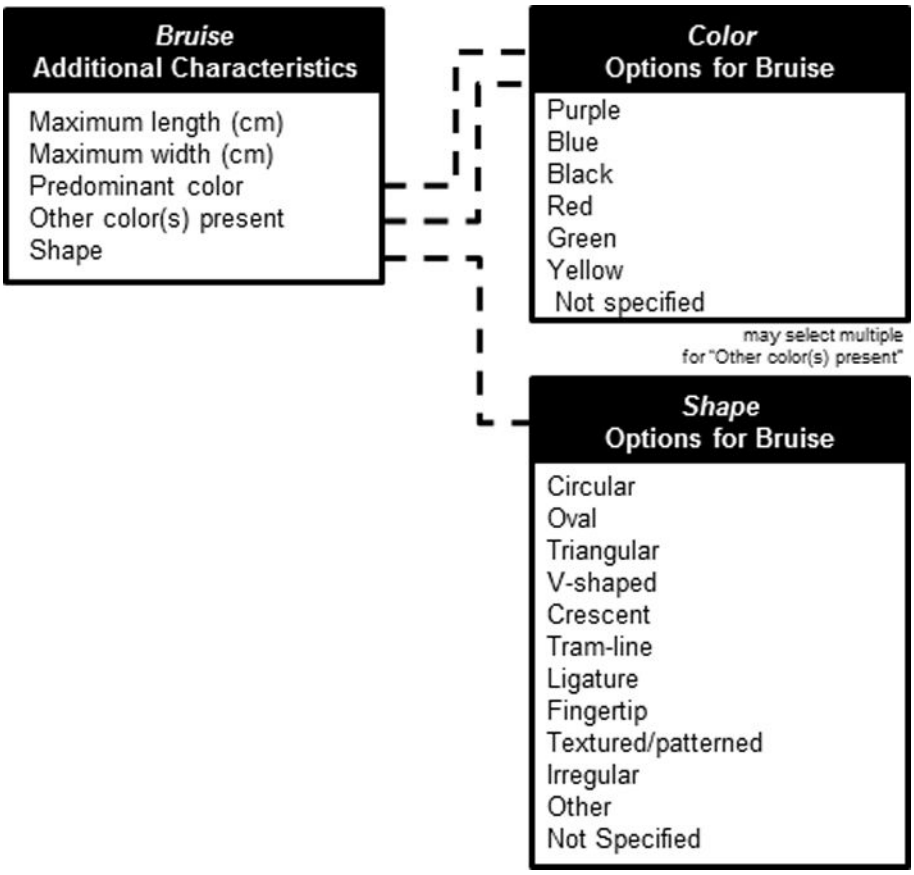

Figure 3.
Critical additional characteristics and options for selected characteristics for classification of bruises

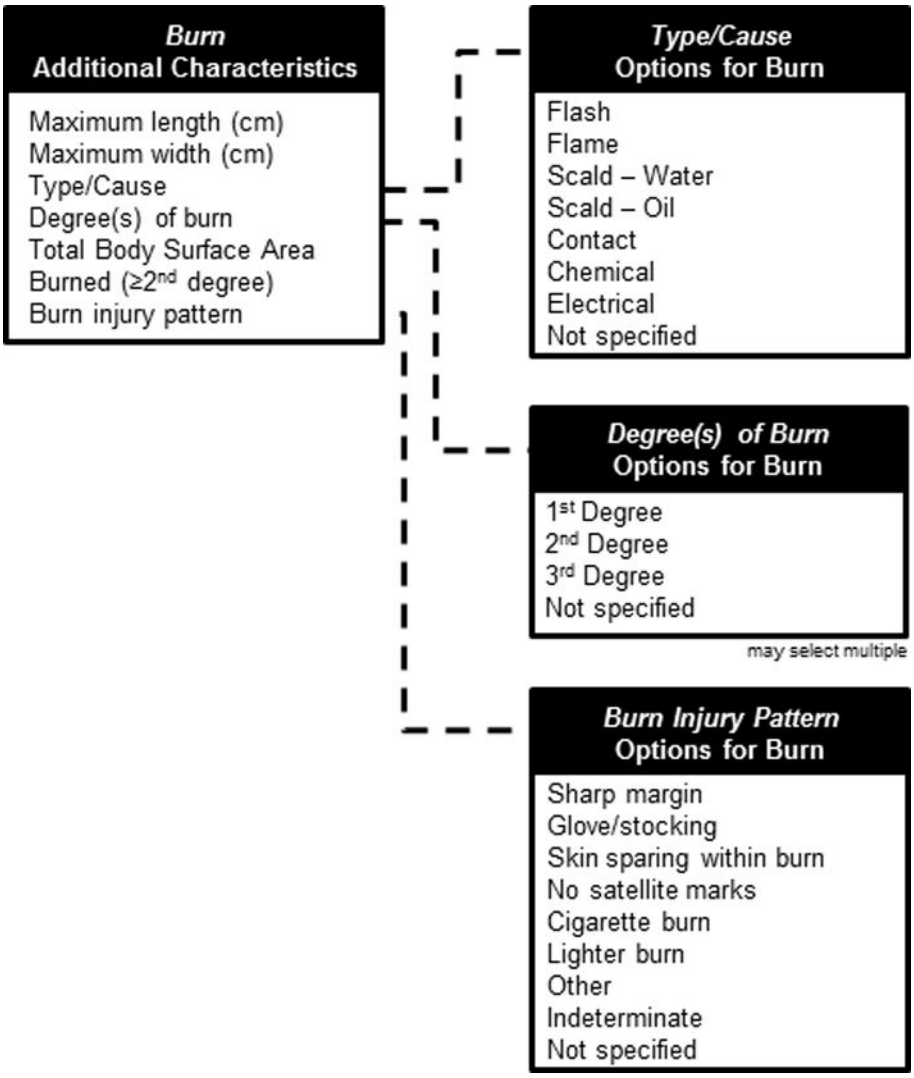

Figure 4.

Critical additional characteristics and options for selected characteristics for classification of burns