Noninvasive Peripheral Pulse Monitoring Using Photoplethysmography for Pre-Hospital Bone Reduction

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Distal pulse assessment during closed fracture reduction in pre-hospital emergency care is typically performed intermittently and subjectively, leaving windows where vascular compromise may go undetected. This study presents the design, construction, and testing of a photoplethysmography (PPG)-based pulse monitoring device intended to provide continuous, real-time detection of pulse presence and absence during pre-hospital bone reduction procedures. The device utilized an ADPS-9008 photosensor and green LED light connected to an Arduino UNO microcontroller, with an alert system driven by a passive piezo buzzer and a multicolor LED indicator to signal changes in perfusion status. Pulse detection was based on analog signal peak identification relative to a calibrated threshold, managed using the PulseSensorPlayground library. Device performance was evaluated using a hemodynamic three-dimensional vascular phantom capable of simulating physiologic blood flow under controlled conditions. Across 50 experimental trials, the device achieved a detection accuracy of 94% across all trials, and 95.9% when excluding one trial disqualified due to improper sensor securing. The two detection failures both involved delayed pulse restoration recognition, while pulse loss was identified correctly in all 49 valid trials. These results support the feasibility of a low-cost, noninvasive PPG-based monitoring device for continuous distal pulse assessment in prehospital trauma settings and establish a basis for further refinement and clinical testing.

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