# Pneumatic Nail Guns

## Revisiting Trigger Recommendations

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**Pneumatic framing nail gun use** is ubiquitous throughout the modern homebuilding industry. This tool has dramatically increased framing productivity beyond what could be achieved with a hand hammer. However, the dramatic increase in productivity introduced a new injury:

> You're using a gun to do something faster, and fast isn't safe. . . . It might be making it easier, but all around, it's shooting projectile at a high speed to go through hard materials. It's just dangerous to work with. (Union carpenter, St. Louis, MO)

**IN BRIEF**

- **Use of a pneumatic nail gun with a sequential actuation trigger (SAT) significantly diminishes the risk for acute traumatic injury compared to use of a nail gun equipped with a contact actuation trigger (CAT).**
- **A theoretically based increased risk of work-related musculoskeletal disorders from use of an SAT nail gun, relative to CAT, appears unlikely and remains unproven.**
- **Based on current knowledge, use of CAT nail guns cannot be justified as a safe alternative to SAT nail guns. The authors, who are ergonomists and occupational safety researchers, recommend the use of the SAT for all nail gun tasks in the construction industry.**

Before pneumatic nail guns were available, nail puncture injuries on a construction site typically occurred when a carpenter or other tradesperson stepped on a nail protruding from a piece of lumber. Carpenters did not accidentally drive nails into their own bodies or that of a coworker with repeated strikes from a hammer. However, such injuries became more common when pneumatic nail guns were introduced to drive nails at a high speed to go through hard materials.

Pneumatic nail guns have a safety device (workpiece contact, nose, yoke, tip) at the end of the gun muzzle that must be depressed before the fastener can be discharged. Generally, these devices have two types of trigger systems that then define how the nail gun fires in response to a trigger press:

1) The sequential actuation trigger (SAT) requires that each nail can only be discharged when the safety tip is first depressed and, while held depressed, the trigger is squeezed.

2) The contact actuation trigger (CAT) allows the operator to first squeeze the trigger and, while holding the trigger squeezed, repeatedly bump the safety tip on the workpiece to shoot multiple nails.

Of these two trigger mechanisms, the SAT provides a positive safety advantage (European Committee for Standardization, 2009; Stanley Works, 2002) in that it prevents the unintended firing of a nail that can otherwise occur when the trigger is depressed and the workpiece contact is bumped (Photo 1, p. 32).

Traumatic injuries can occur when an operator using either type of actuation device intentionally discharges a nail that subsequently penetrates through the wood or misses it altogether. However, an SAT-equipped nail gun is much less likely to be discharged unintentionally, as the trigger must be activated while the safety tip is depressed against the workpiece (NIOSH/OSHA, 2011).

Unintentional nail discharge using a CAT-equipped device typically occurs following nail gun recoil (resulting in a double fire—a second, unintended shot) or when the operator has his/her finger on the trigger and the nail gun nose inadvertently contacts an object (Lipscomb, Dement, Nolan, et al., 2003). Although operators are advised to not hold the trigger in the depressed position when not intending to shoot a nail, a nail gun's physical characteristics, including weight (8 lb to 9 lb), balance, trigger location and hand-grip design, make it easier to hold the gun with a full power grip that includes the index finger (Photos 2 and 3, p. 32-33).

### Nail Gun Injury Studies

Portable pneumatic nail guns have been used to frame new wooden structures since the mid-1960s and gradually replaced the framing hammer as the tool of choice. As pneumatic nail gun use increased in the 1980s and 1990s, so did the number of medical case reports of pneumatic nail gun fatalities and

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traumatic injuries to the head, eyes, chest, and the lower and upper extremities.

Washington State Department of Labor and Industries published the first nail gun injury epidemiology report in 1999 (Baggs, Cohen, Kalat, et al., 1999) and a version of it was later published in *Professional Safety* (Baggs, Cohen, Kalat, et al., 2001). The study reported an analysis of workers' compensation claims for nail gun injuries that occurred from 1990 to 1998 in Washington State. The injury incident rate for building construction workers (SIC 15, Building Construction) was 78 incidents per 10,000 full-time equivalent (FTE) workers/year, while the incident rate for wood framing tasks was 206 per 10,000 FTE.

Dement, Lipscomb, Li, et al. (2003), analyzed Ohio Bureau of Workers' Compensation claims (1994-97) for all Ohio carpenters and residential construction workers employed (1996-99) by North Carolina Home Builders Association members. Nail gun injury rates for the North Carolina and Ohio cohorts were 91 cases/10,000 FTE and 132/10,000 FTE, respectively. A subset of claims was analyzed ($n$ = 185) that included written narrative descriptions of the injury incident and the authors concluded that at least 69% of the incidents may have been the result of an unintentional nail gun discharge or misfire.

Lipscomb, et al. (2003), investigated all acute work-related injuries ($n$ = 783) among a St. Louis, MO, carpenters' union apprentice cohort working in the residential building industry (1999-2001). Nearly 14% (80) of the injuries involved nail gun use. The rate for apprentice carpenters was higher (3.7/100 FTEs) than that of journey-status carpenters (1.2/100 FTEs). A majority of injuries occurred when the CAT mechanism was used and the authors concluded that 65% of the injuries could have been prevented had the nail guns been equipped with an SAT mechanism.

Lipscomb and Jackson (2007) analyzed reports of nail gun injuries treated in U.S. hospital emergency departments from 2001 to 2005. The range in annual occupational related injuries was 19,300 to 28,600, with an annual average of 22,200. Most injuries were to the upper extremities (66%) and lower extremities (24%); bone fractures were involved in 4% of the injuries. The data did not include information describing nail gun actuation systems being used when the traumatic injuries occurred.

Clearly, using pneumatic nail guns presents the potential for serious injury or death. An unpublished review of nine nail-gun-related fatality investigations in the OSHA Integrated Management Information System revealed three cases that were

**Photo 1: The full SAT nail gun is safer because it requires that the two controls be actuated in a specific sequence. First, the safety tip is pressed against the lumber (left panel), then the trigger is depressed to fire the nail (middle panel). When the nail gun fires, recoil of the tool away from the workpiece (right panel) can result in a second, unintended, contact of the safety tip. With the SAT, a nail will not fire on the second contact because the trigger must first be released and then actuated after the safety tip. Conversely, a CAT-equipped nail gun fires with the controls actuated in either sequence and the trigger need not be released between successive nails fired.**

clearly attributable to the CAT trigger (that is, preventable with SAT) and five cases that lacked adequate information to clearly determine the role of trigger type in causation. Only one fatality case was deemed to have been clearly unpreventable with SAT. It is also known that the SAT system provides a positive safety advantage over the CAT system. Despite this, the CAT system is more likely to be used than the SAT system.

One anecdotal argument against using the SAT system is the potential for developing trigger finger (stenosing tenosynovitis) as a result of the need to squeeze the trigger for each nail discharged. Baggs, et al. (2001, p. 37), provide an opinion that nail gun operators use the SAT system. However, the earlier SHARP report (Baggs, et al., 1999) included the following:

> As employees gain experience with the tool, the "bump" (CAT) trigger system can be implemented to reduce the potential risk of musculoskeletal disorders (e.g., trigger finger). Manufacturers should work with users and safety professionals to better balance speed and productivity of using the "bump" mode with accuracy and potential for fewer acute trauma injuries using the sequential mode. In all cases, the possibility of trigger finger must be considered.

The technical report and subsequent article (Baggs, et al., 1999; 2001) recommend that the SAT should be used, postulating that the SAT device likely poses less traumatic injury risk to the user. As such, less experienced nail gun users were encouraged to use the SAT to reduce the likelihood of injury. Transition to a CAT-equipped nail gun was opined to provide speed and productivity advantages over the SAT and diminish risk for musculoskeletal disorders, implying a possible differential risk for work-related musculoskeletal disorders between SAT and CAT nail guns. These opinions were not necessarily intended as policy guidelines. In the years since these documents were published, no evidence has emerged in the medical case report, or the ergonomic or injury epidemiology literature to indicate that use of the safer single-shot SAT trigger mechanism differentially increases a worker's risk of developing a work-related musculoskeletal disorder.

Other guidance at that time also suggested that risk factors for cumulative trauma disorders/repetitive strain injury be considered in the adoption of SAT systems. For example, in 2001, the New Zealand Department of Labor published "Guidelines for the Safe Use of Portable Mechanically Powered Nailers and Staplers." These guidelines acknowledge risk of overuse syndrome with SAT, but only in high-volume production when "thousands of trigger pulls every day" are required. The New Zealand guidelines only allow for CAT use under safely managed high-volume pallet and wood crate assembly operations (not construction work) when a number of nail gun management, operator training and workstation design requirements are met.

The authors suggest that theoretical concerns about the development of specific stenosing tenosynovitis symptoms from use of SAT-equipped devices have not been confirmed by either surveillance or biomechanical evidence. A recent NIOSH study conducted to assess finger displacement and predicted finger tendon travel did not result in cumulative tendon travel at the levels previously associated with hand/wrist musculoskeletal disorders (Lowe, Albers, Hudock, et al., 2013).

A second NIOSH study (Albers, Hudock & Lowe, 2013) queried residential building framing subcontractors and carpenter framers working in nine focus groups conducted in five states. Some focus group participants described having developed or knowing someone who developed carpal tunnel syndrome related to nail gun use, irrespective of the trigger mechanism they used. No participant, however, described the same for trigger finger with either actuation system.

**Photos 2 and 3: It is natural and more efficient to grip a tool handle with a full power grip, which includes use of the index finger in the grip. With most nail guns, the index finger must actuate the trigger to contribute to the grip of the tool.**

None of these observations specifically refutes a potential association between SAT use and finger tendon cumulative trauma. Collectively, however, they cast serious doubt on the existence of a problem—for which no documentation exists—attributable to a specific trigger system. When contrasted with the overwhelming evidence in support of traumatic injury risk reduction with the SAT, it seems imprudent to justify any recommendation other than the use of SAT in the context of construction safety and health.

Unfortunately, the awareness of overuse syndrome potential can be easily cited out of context, creating the impression that overuse syndrome is differentially associated with SAT use in construction work with nail guns. Misappropriated emphasis on the theoretically based causation of repetitive motion injury (e.g., trigger finger) may distract from the evidence-based acute traumatic injury risk.

This can be seen clearly in nail-gun injury litigation defense and in recommendations from OSH agencies. For example, in *Martin Oliver v. Hitachi Koki USA Ltd.* (2012), the defense drew specific attention to the SHARP (Baggs, et al., 1999) and New Zealand (2001) documents to justify use of CAT based on a theoretical reduction in repetitive motion injury risk. In a 2009 Hazard Alert on nail guns, Oregon OSHA described nail gun safety hazards. However, one recommendation stated, "Use the bump action trigger for . . . rapid nailing on flat, stationary surfaces such as decking, sheathing and siding. This mode is very fast and can reduce the risk of musculoskeletal disorders such as trigger finger."

In the authors' view, an unintended consequence of the recommendations published in 1999 and 2001 has been the creation of the appearance of competing risks with nail gun trigger systems. This may undermine policy efforts to reduce the high prevalence of traumatic injury attributable to CAT-equipped devices.

## Conclusion

Work-related musculoskeletal disorders among carpenters and other construction workers are a genuine concern. Additional research is needed on risk factors such as forceful exertions, repetitive movements and awkward postures associated with construction tasks and nail gun use irrespective of the triggering mechanisms used.

However, at present, no evidence shows that the SAT differentially increases risk of developing trigger finger or any other work-related musculoskeletal disorder. In contrast, overwhelming epidemiologic evidence indicates that the CAT trigger mechanism increases the risk of unintentional nail discharge and associated injuries, and that the SAT trigger mechanism provides a positive safety advantage. Given the current state of evidence regarding traumatic and cumulative trauma injury risks in construction, "the full sequential trigger is always the safest trigger mechanism for the job" (NIOSH/OSHA, 2011, p. 6). **PS**

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