BOOK REVIEW

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A Review of: Wound Ballistics–And the Scientific Background

REFERENCE: Sellier KG, Kneubuehl BP. *Wound Ballistics—and the Scientific Background.* Amsterdam, Elsevier, 1994, p. 479.

This is the English translation of a book published, in German, by a different publisher (Springer, Berlin) in 1992. Unfortunately, the translation is seriously flawed. It varies from the stilted and comical to the incomprehensible:

- using "sensibility" where "sensitivity" is meant (p 75, 13th line of text from top);
- using "sheaf" where "column" is needed (p 85, last line);
- using "charge" where "lot" or "batch" is probably meant (p 192, lines 7–9 from top);
- "Surprisingly, the sphere often did not stop at the actual end of the shooting channel." (p 133, 15th line from top);
- "—velocity of the projectile v_{stk} at the moment when the projectile is stopped." (p 224, 13th line from bottom) "Stopped" projectiles, obviously, do not have any velocity.

The most serious problems with this book, however, are its many factual errors, inconsistencies, and its presenting flawed assumptions as fact—while ignoring contradictory evidence. These include:

- p 149—Sellier and Kneubuehl (S&K) assert that for every Joule of energy expended by a penetrating projectile in muscle tissue:

.77 cc of temporary cavity volume will result
.35 cc of "bleeding zone" will result
.03 cc of permanent cavity will result.

Such constants would have to be derived from experimental measurements. S&K fail, however, to refer to any such experiments. They also fail to indicate to which muscle or muscle groups these constants are intended to apply—and in what animal.

The amount of tissue removed in operating on a gunshot wound does not necessarily correlate with amount of tissue severely disrupted by the penetrating bullet. Any surgeon experienced in treating gunshot wounds knows that *much of the tissue that is removed when operating on some gunshot wounds is not tissue that is irreversibly damaged*, but is healthy tissue that is excised simply in order to smooth the wound's walls, to eliminate blind pouches, and shape the wound so there are no overhanging edges: to tailor the wound so it will be easy to close later.

The constants presented by S&K bear a striking resemblance to those presented by French and Callender on page 140 of Beyer (*Wound Ballistics*), a book which S&K list in their bibliography but do not give any credit for the constants presented on p 149. French and Callender also failed to give any reference to supporting experiments, and to which muscles in which animal their unsupported constants were meant to apply.

- p 148—In the schematic drawings of tissue movement from temporary cavitation (Fig. 5.2.9) an area a few inches from the bullet path is labeled "undisturbed tissue." Since solid tissue (such as muscle) is basically incompressible, the tissue movement caused by the temporary cavity is transmitted like a wave in water: the disturbance becomes gradually less as distance increases, but tissue up to several feet away is often moved (or "disturbed") visibly by cavitation: this has been verified repeatedly by using high-speed cine cameras to film shots into anesthetized animals.
- pp 148–149—The explanation that attempts to support the fallacious idea that a "firm reciprocal and numerical ratio" exists between the radii of the permanent and temporary cavities, and that a uniform cylinder of microscopic damage ("extravasation") surrounds the permanent cavity, is confused and confusing. The same claim is made for a "relationship between the size of the temporary cavity and the amount of devitalized tissue" on p 299, accompanied by a different schematic drawing. S&K present no data and no references in support of these concepts. In fact, copious evidence exists which *disproves* the geometrical consistency S&K claim for uniformly disrupted muscle around the projectile path. *The variation in anatomic location of the bullet path in relation to the blood supply of various muscles guarantees a nonuniformity in damage patterns.* This nonuniformity of damage has been verified repeatedly.

Flexible human tissues, such as muscle, must be stretched beyond a certain point before they tear. The "energy" that goes into forming a temporary cavity that stretches tissue below the point where it tears is absorbed without causing damage: one might consider it wasted if damaging tissue was its goal. Consequently, the postulated linear relationship between the size of the temporary cavity and the amount of devitalized tissue, upon which so much of S&K's book is based, is demonstrably incorrect.

- pp 297–302—The "debridement" section claims that "debridement" comes from the French "debris." Actually, it comes from the French verb "debrider" which means to release tissue tension by incising constricting layers or bands—an operation that we call a fasciotomy. This section contains graphs from studies which purported to show that the amount of devitalized tissue removed in treating a gunshot wound is proportional to the amount of kinetic energy lost by the bullet. S&K overlooked flaws which invalidate these studies: 1) results depended entirely on the subjective judgment of the surgeons who decided which tissue to remove, yet the studies were not blinded 2) no control animals were used—there was no way to verify that some (or all) of the tissue removed would not have survived if left in place. S&K overlooked studies which showed "that the degree of tissue damage was *not* comparable to the amount of energy delivered to the tissue" (my emphasis).

• p 108—under "kinetic energy of the gasses" we find "For an approximation of their [powder gasses] kinetic energy, we normally calculate one half of the projectile velocity." Below, in Table 4.4.2, they give "kinetic energy of the gasses" (from a .308 Winchester) as 1640 J—*which is one half as much as the kinetic energy of the bullet.* First, if they use one half the projectile velocity, that would make the kinetic energy of the gasses one fourth that of the bullet (velocity is squared in the kinetic energy formula). Second, since the mass of the powder is only one third the mass of the projectile, this would make the kinetic energy of the powder gasses only one twelfth as large as the kinetic energy of the projectile—or 272 J—not 1640 J.

• pp 281–292—S&K discuss studies by researchers who claim to show "remote effects" in tissue cultures and in live pig nerve tissue. By attributing these "changes" to "shock waves" (more properly called the sonic pressure wave) the researchers overlooked the fact that the same tissues that were subjected to the "shock waves" were also subjected to transmitted tissue movement from temporary cavitation. If there were any changes they were far more likely to have been caused by cavitation, which moves tissue perceptibly, than by "shock waves," which cannot. This was pointed out in a letter to the editor published in 1989.

• p 231—We find "the penetration of projectiles into the tough animal skin consumes much more energy than is the case with human skin." S&K present no data to support this assumption. In recent tests, the penetration threshold velocity in the skin of the abdomen of a freshly killed 20 kg pig was found to match closely the threshold velocity values for human skin reported in the literature.

• p 231—Under "Penetration Capacity in Bones," we find "The threshold velocity v_{ths} for bones lies around 60 m/s. Human bones vary greatly in strength and thickness, from the mid-shaft of the femur to the almost paper-thin central part of the scapula—no single penetration threshold velocity can possibly apply to them all. In my forensic wound ballistics practice, I have had two cases in which *9 mm Parabellum 7.5 gm (115 grain) WW Silvertip bullets, fired at a distance of no greater than 10 m, failed to penetrate or break human bones.* In one case the bullet hit the mid-portion of a femur, traveling perpendicular to the long axis of the bone, and flattened and fragmented on the bone. In the other case it struck the body of the second lumbar vertebra, entering from the back and side at a 45 degree angle: it also flattened and fragmented on the bone. In both cases the persons hit were young, healthy adult males, and each bullet had perforated about two inches of muscle before striking the bone. Figuring a loss of about 61 m/s (200 ft/s) in perforating the muscle, these bullets struck the bone at about 305 m/s (1000 ft/s). *Both struck at more than five times the velocity that S&K claim as their penetration threshold velocity for bone—yet neither penetrated the bone.*

• p 245—S&K misquoted and misinterpreted the work of Hatcher. They claimed he wrote "that LAGARDE's test results (from corpses) would fit the momentum formula better than they do the energy formula." Hatcher actually wrote "It will be seen that by the momentum formula, the figures are in substantial agreement with the results given in LaGarde's book, where the .30 failed to down any animal after ten shots, while the .38 downed them after say seven shots, the .45 after say four, and the .455 and .476 after three." When Hatcher is quoted correctly, it is clear that he correlated his momentum formula with the bullet comparison tests on live beef cattle and horses—not on corpses.

• p 162—Fig. 5.2.18—Common bullets for army rifles. Cross sections of six bullets are shown: S&K show only one 7.62 × 39 mm (AK 47) bullet—with a lead core. The Russian (and Chinese) 7.62 × 39 mm ball round *with a large steel core* is probably the most common military rifle bullet in the world: failure to include it is a serious oversight.

This book is somewhat akin to a computer literature search. Much insignificant work is listed in enough detail to imply it is significant. Many seriously flawed works are discussed with little or no indication of their faults. Its organization is repetitive and disjointed. The 42 page "Physical basics" chapter purports to provide the background in physics needed to understand the formulas which permeate the book—from Newtonian mechanics to thermodynamics. This sketchy outline of these subjects is not needed by those who understand physics, and is likely to confuse those who don't. It would have been better to integrate this material into the sections where it is applied.

The book ends with 61 pages of tables, followed by a 63 page glossary. The tables are mostly bullet velocity loss over distance, in both metric and English units. They extend only to 150 yards for handgun bullets and to 300 yards for rifle bullets. The *Sierra Manual,* which any American reader of this book is likely to have, is a much more complete and useful reference in this regard—and anybody who needs to convert to metric units can do so, very simply, using a few well known constants. The glossary is an English-French-German ballistics dictionary: this was undoubtedly a useful addition for the German edition; it seems to me far less useful in the English one.

S&K's book contains so many errors and misconceptions that it is risky to take anything it includes without independent verification. The book's price is a whopping $148.50.

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