Evidence-Based Loss Control

If not now, when?

By Carl R. Metzgar

THE PROFOUND QUERY, "To be or not to be: that is the question" has been pondered since at least 1600. Conjecture or evidence is today's pressing practical question. What is safety? What is the role of evidence in safety? Safety is an ordinary word often used in contradictory ways. Safety can be defined as "a state or situation characterized by an adequate control of physical, material or moral threats and which contributes to a perception of being sheltered from danger" (Andersson and Svanstrom 2). This definition contains no absolute identifiable or measurable anchor. "Safety is a dynamic state" (Svanstrom 2). The definition of safety and safety processes are like two gas clouds, not forming compounds as they meet, but merely passing through each other. Only part of safety and its definition can be captured at any one moment, just as only a few molecules of the gas clouds strike each other. This ambiguity makes safety a most difficult word to use.

For analytical and action purposes, "loss control" is a more useful concept since a loss can be identified for analysis and follow-up. Injury, disability derived from pain, property damage and business interruption are losses that can be reduced to a common monetary denominator. Losses can be measured in a precise way that safety cannot—that is, disability can be measured, pain cannot be measured. That's why workers' compensation laws do not require payment for pain but do require payment for disability. This difficulty in evaluating pain is similar to that encountered in defining safety. Since a loss can be defined, it is easier to define loss control (hence the choice for evidence-based loss control rather than evidence-based safety).

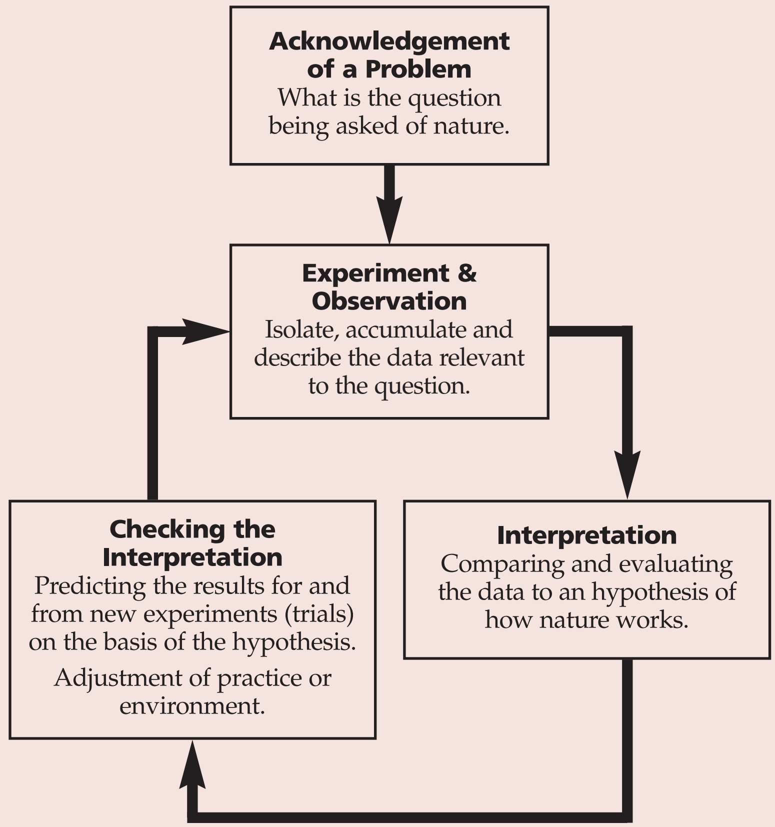
A loss is an identifiable and quantifiable injury or damage, with personal injury and property damage the most easily found losses. Losses due to interruption of manufacturing or service processes are more difficult to identify but can be quantified in proportion to the effort expended in capturing costs. Activities and programs are more likely to succeed when they are based on reproducible facts and procedures. New loss prevention efforts based on past quantifiable successes are likely to be more rewarding than those based on hip-shots and hope. Management's haste to be seen doing a visible "anything" often rules out doing a useful "something." Identifiable and quantifiable facts must be specific in order to be transformed into evidence, and significant effort must be expended to rule out ambiguities. The transformation of observations and careful deductions into evidence supplies the basis for evidence-based loss control.

Evidence

Evidence is commonly considered to be observable phenomena from which people make inferences that are important at a given moment and for a specific purpose. In transforming facts into evidence, one must adjust from the physical to the cerebral. Language is the device used to make the transformation. "In normal linguistic usage, the meaning of 'fact' is ambiguous. It can refer to a statement that expresses the fact and it can also refer to the state of affairs referred to by such a statement" (Chalmers 10). Observable phenomena may be said to be fact 1. A statement or inference about fact 1 becomes fact 2. The state of affairs referred to by such a statement is fact 3. Thus, class 2 facts are once removed from class 1 facts, while class 3 facts are twice removed from class 1 facts. The same bit of evidence or the same inference will be viewed differently depending on the demands of the situation. Particular needs will be different at different times depend-

Figure 1

A Loss Control Scientific Method



A scientific method requires a question that can be answered from the natural world. The occupational or recreational world is a part of the natural world. The search is done by carefully experimenting and observing phenomena. In loss control, that often means closely examining the natural laboratory of the workplace. The observations are scrupulously and systematically recorded. With data accumulated interpretation follows. The interpretation must be tested in order to be useful. The test is essentially a new experiment.

A usual step in the scientific method is to publish results of the investigation for others with a similar background and questions so that results can be evaluated in light of as much experience as possible. Publication of results initiates criticism that is the self-correcting mechanism of science and eliminates the untested claims of authority.

ing on the discipline. Bias in observation is inevitable and sterile; detached evidence is never available. "Perception may be 90 percent memory" (Gregory). Eyewitness testimony once thought to be the "gold standard" of evidence is now known to be unreliable in many respects (Kassin).

Sensory experience is stored in memory. Accumulated memory influences any subsequent perception, observation and conclusion. Any inference is at least once removed from physical phenomenon; therefore, some bias will creep into inferences due to previous experience and thought. Since observations and inferences are imperfect, evidence based on them becomes more or less probable. "Thus, inferences from such evidence can only be probabilistic in nature and our conclusions have to be hedged" (Schum 2).

Consequently, it becomes necessary to allow for the probable nature of evidence in loss control considerations, making astute evaluation of probability in loss control more challenging than handicapping horses. Consider the sources of the typical basis of loss control thinking: undocumented claims and statements in various publications; ratios published that were never subjected to peer review; claims (without references) by speakers at professional gatherings; and hearsay (such as the urban legend about someone who tried to trim a hedge with a lawnmower).

On the other hand, Boyle and Charles's laws still seem to be effective in describing the properties of gases. Water is made up of hydrogen and oxygen, but even it has irregularity. It took rigorous science to dispose of "polywater" (Gratzer 83). Most metals expand when heated and contract when cooled; however, it is necessary to identify and document the exceptions. Clearly, it takes tremendous, concentrated, ethical effort to uncover facts that can be raised to the level of evidence.

Evidence from research is the basis for the behavioral safety movement. Behavioral books and articles are typically well-referenced. A related but separate text, *The Psychology of Work Behavior,* has 843 references to help the reader follow the argument for the behavior of workers including and beyond safety (Landy R-1 to R-40). References are tools for examination and building of insights that may become evidence and the basis for action. It is useful to examine references that accompany any article to make sure they actually support the statement to which they are attached (Gaddis 276). The best work is based on observation.

Physical phenomena make up a significant part of the considerations in loss control evidence. However, psychological, sociological and organizational inferences also influence conclusions, as do many organizational considerations, which are intertwined with leadership theories and practices. Managerial leadership (or the lack of it) has a major effect on loss control results.

The mixed hard and soft science requirements of loss control are complex. The evidence for action and skills for implementation are drawn from diffuse disciplines, so one must canvass these same disciplines for relevant information. Medicine is an example of this process at work. The field is well-served by comprehensive indexing of relevant science. For example, Index Medicus indexes 3,400+ journals for the field. Medical writers use it and additional databases, then canvass their colleagues to make sure they have not missed anything. No comparable database exists for loss control—its relevant evidence has not been centralized. Useful loss control facts can be found in most databases in the hard and soft sciences, including medicine, but the search is not simple. Yet, however difficult it may be to develop credible evidence, physical phenomena and disciplined inferences are superior to opinion, so one must seek out the best information from many databases.

Questions are crucial for developing evidence but are not, themselves, evidence. Questions do, however, generate answers that may be statements and eventually evidence. The power of the question establishes the utility of the answer. The framework for generating and developing questions and responses is called science.

A Scientific Method

Physics is generally considered the queen of the sciences and is credited with evolving from observations. "What is so special about science is that it is derived from the facts, rather than being based on personal opinion" (Chalmers). Science has its orthodoxies and authorities, but its very nature means that its facts and their interpretations are always subject to review and correction. Conscientious criticism is the built-in self-correcting mechanism for science. Aristotle was the first great scientific thinker and many of his conclusions have been disproven by subsequent experiment and observation—but no one thinks less of him for it. Loss control needs less appeal to authority and more experiment with observations followed by challenging review and criticism.

Haddon, an early loss control theoretical thinker and practical applicator, made an interesting observation on how science matures.

> The accompanying transition in categorizations of the phenomena of the field has many precedents in medicine. It is the shift from descriptive thinking and nosology [the systematic classification of diseases] to categorizations in etiologic terms. . . . [the] ability to describe human morbidity and mortality etiologically requires an understanding of causation. Hence it opens the door to the possibility of manipulation and control (Haddon(a) 1431-32).

Five years later, he suggested another advance and emphasized process over description.

> An important landmark is reached in the evolution of a scientific field when classification of its subject matter is based on the relevant, fundamental *processes* [emphasis added] involved rather than on descriptions of the appearances of the phenomena (Haddon(b) 321).

In my opinion, loss control has not emerged from Haddon's descriptive stage. Losses are still listed, added together and broadcast with limited effect. This suggests that the analyses of the process of causation and control are the most productive sources for questions. Progress will come from the evidence of what is occurring in those processes that cause losses. The systematic search for evidence, with its submission to peer criticism, is a key use of the scientific method. Science is based on public knowledge from reproducible evidence. Science is public, whereas experience and art are personal.

> Art is something that depends on individual experience and cannot always be communicated to someone else; science, on the other hand, must be communicated if we are ever to add to the body of knowledge, whether that knowledge is to be related to blood flow, nuclear fission or work motivation (Landy 4).

Evidence-Based Loss Control

Evidence-based loss control is a continuous, problem-based discovery and learning process that is a variation of a scientific method. The following five steps are the skeleton for supporting and concentrating the search for what must be known to satisfy the information need.

1) Convert information needs into focused questions.
2) Investigate the best evidence with which to answer the question.
3) Critically appraise the evidence for validity and operational usefulness.
4) Possibly apply results of the information search in the operational setting.
5) Evaluate performance of the evidence in operational application.

Convert Information Needs Into Focused Questions, Information Into Evidence

A loss control challenge must be reduced to a need for information. For example, an exposure to some sort of risk needs to be mitigated (e.g., a process change). The notion that facts or evidence may be missing and the nature of the risk or solution registers as a need for information. If information is incomplete, a question is developed to obtain answers that will contribute to more complete understanding. Discovering and developing facts into evidence is the productive response to a question.

A well-asked question is one that can be answered. If it is too narrow or too broad, the answer will be trivial. A well-asked question is half the solution; it anticipates the existence of evidence or points toward facts developed from physical phenomena. Facts to be transformed into evidence must be accumulated and established to contribute to conclusions and actions. A well-asked question is manageable. Since evidence will be arrived at by a scientific method, one can reasonably expect that the evidence and the answer will change over time based on subsequent challenge and review. The solid orthodoxies of science are subject to change, which is the exact opposite of the resort to authority.

Investigate the Best Evidence With Which to Answer the Question

A search engine is not a database; it is "a program that searches documents for specified keywords and returns a list of the documents where the keywords were found" (Webopedia)—think of it as the library card catalog. A database is "a collection of information organized in such a way that a computer program can quickly select desired pieces of data" (Webopedia)—think of it as the books in the library. Thus, a database is an accumulation of information and the search engine is the method to locate it. Data or information may or may not be raised to the level of evidence.

Loss control information is distributed throughout the disciplines it touches. Tracking down what needs to be known requires curiosity, persistence and sound judgment. Information is both displayed and hidden in infinite ways. The search of computerized databases is productive, but significant amounts of information can be found in books as well. The indexes of various magazines and journals are also useful, as is calling on colleagues for guidance and additional sources.

Information searches may go forward and backward. For example, a current periodical reporting primary work includes the references used; reading those references will take an investigator backwards. Conversely, one can use the indexes to determine where a paper has been cited since its publication. When properly used, indexes increase search efficiency considerably.

Critically Appraise Evidence for Validity & Operational Usefulness

Once accumulated, information must be evaluated. Critical skills are important because, except for personal observations, the information is at least once removed from an observable phenomenon—and probably multiple steps from a class 1 fact. Cultivating critical skills is a maturation process and is achieved with practice. For example, the federal government may be the country's biggest publisher, but, in my opinion, cultivated skepticism is never out of place when using its materials. Keep in mind that the government's primary goal is survival, not objectivity. Survival imposes a bias on its publications that can confound the information published.

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lished "Worker Deaths by Falls," which reviews 8,102 falls [using information from the NIOSH Fatality Assessment and Control Evaluation (FACE) database] that occurred between 1982 and 1997. On page 8, the report states, "FACE data may not be generalized to fatal falls from elevations." That is a warning. The study includes descriptions of 90 fatal fall incidents with no explanation of how those incidents were selected from the 8,102. Without such information, the incidents are anecdotes and do not achieve the status of evidence. "Anecdotes—stories recounted in support of a claim—do not make science. Without corroborative evidence from other sources, or physical proof of some sort, 10 anecdotes are no better than one, and 100 anecdotes are no better than 10" (Schermer 49).

These anecdotes have already been mistakenly taken as evidence. In "Height Doesn't Matter," Bierma repeats parts of three descriptions from the NIOSH report (28). So, of the original 90 anecdotes, three are used to project a conclusion that NIOSH specifically warned against. Had the agency described how the 90 anecdotes were selected, they might have been raised to the level of cases and, thereby, possibly become a representative sample. Furthermore, the article's catchy title may mislead some inexperienced loss control practitioners. Decisions based on this information will be made on the basis of anecdotes, not evidence. Height does matter, just not in the linear fashion assumed by most. Height must be qualified as a contributor to injury evidence just like any other factor.

In contrast, Goodacre, et al published "Can the Distance Fallen Predict Serious Injury after a Fall from a Height?" These authors describe how their sample of falls was selected. The limitations on the generalization, "height of a fall is a poor predictor of major injury," carefully indicated that the range of the falls was 6.6 to 32.8 ft. and that height is only one causal factor to be considered. This article is based on evidence; the other article is based on conveniently selected anecdotes.

One can draw significantly different conclusions from these three sources. The Goodacre article is based on qualified observations. The NIOSH publication is based on a report of reports. The Bierma article is a report based on the report of the report of reports; as such, it is far removed from physical phenomena as a source of evidence for any course of action.

The extensive literature on alcohol and drunk driving provides another example. One would expect that the quality of the research would be high. However, in Wagenaar's meta-analysis (any systematic method that uses statistical analysis to integrate the data from several independent studies) that reviewed 54,708 studies, only 161 studies survived the initial screening criteria (Wagenaar(a) 9). In his own study, Wagenaar reviewed 6,500 studies from 18 databases, of which 125 survived the criteria to be included in the meta-analysis of "drunk driver literature" (Wagennar(b) 308-9). He also noted that "over half of the U.S. evaluation literature on DWI deterrence is found in government reports, and almost a third is found in journal articles" (312).

Clearly, the search for, and location of, good information to turn into evidence is a daunting task. Review of published sources and criticism of colleagues all contribute to the transformation of accumulated facts into evidence. Field observations may be necessary as may fresh experimentation for discovery or confirmation. In loss control, the experimenter/observer is often inside and part of the experiment, which confounds information developed.

Evidence is regularly associated with the courts, which have a long history of qualifying evidence for their use. Judges recognize that they need help to understand science and statistics in order to evaluate experts and their testimony. To help them, the Federal Judicial Center has published the *Reference Manual on Scientific Evidence.* Five of the 13 chapter headings reflect the areas of knowledge needed to evaluate collected information used in the courts.

- How Science Works
- Reference Guide on Statistics
- Reference Guide on Survey Research
- Reference Guide on Epidemiology
- Reference Guide on Engineering Practice and Methods

These study areas can also be applied to evidence-based loss control.

Because evidence has so many characteristics, its evaluation must be interdisciplinary. Each discipline has its own needs and standards for evidence. The standard for safety research is not good. As Haddon opined in 1963:

> One of the remarkable aspects of motor vehicle accident research has been the willingness of many to base scientific investigations on data of a quality which would immediately cause their rejection as the stuff of research in any other subject area. Motor vehicle accident records as collected by licensing and other agencies are useless for most research of quality, and the burden of proof that this is not the case rests with those who claim otherwise (Haddon(a)).

Since then, improvement has been marginal, in my opinion, and the evidence base for loss control is limited. Major areas of interest to SH&E practitioners are often neither researched nor well-organized. Serious investigation and evaluation are also needed in areas previously thought to be complete and dependable (for example, it was not obvious to expect the weakness in DWI literature uncovered by Wagenaar). A critical component of information evaluation is to know which parts to discard. SH&E is harmed less by what it does not know than what it "knows" that isn't so.

Apply Results of the Information Search in the Operational Setting

Once information is located and organized, a policy, program or procedure can be established. If change is the objective, one needs to test the results of the information search in the environment that precipitated the question. If the evidence is dependable and good judgment is exercised in utilizing it, some part of the expected result should be apparent. However, one must determine, in advance, the objective and its expected application—the expectation needs to be stated clearly so that the result and its variations are apparent. When evidence is relevant and application is judicious, the result should not be a surprise. The scientific method does not allow for shooting the arrow of conclusion, then painting the target of evidence around it. Persistence in discovery and application are keys to understanding and effective action. The new program or procedure becomes a fresh experiment subject to the rigors of science.

Evaluate Performance in Application

Results of the experiment are then evaluated using the established criteria. The search for confounders is continuous. All experiments produce results, but only rigor will allow one to establish a cause-and-effect relationship. All the rigor and evaluation will not make prediction any easier or dependable. The evaluation process must include publication of results for peer criticism. Published results are an invitation for suggestions for further incremental progress in advancing loss control.

Discussion

Some variant of the scientific method is necessary to elevate facts to evidence. Anecdotes are not a firm basis for policy or programming decisions. For loss control to progress, information must be located and organized into evidence. As a first step, a responsible nongovernmental organization needs to support working groups of loss control scientists (including emergency room physicians, psychologists, engineers in biomechanical research, public health researchers, epidemiologists, industrial hygienists and experienced, well-read loss control practitioners) to systematically accumulate evidence on critical deficiencies and to publish reviews of what is known and unknown. These reviews must then be peer reviewed to stimulate additions to the literature and weed out errors and oversights.

Satisfying this second requirement is difficult. The first challenge is to establish who the peers are for a researcher or his/her published work; the second is to account for the bias of these peers at the same time the author and peers are trying to discover and limit the biases in the work. However, the research and reviews of it must be submitted to peer review. This self-correction mechanism remains the most effective method for discovering—and correcting—error in the scientific approach.

Finding or creating the neutral nongovernmental agency will be most difficult; funding it will be moreso. A tremendous amount of useful literature is available for effective, science-based loss control. Science-based loss control then becomes evidence-based loss control. However, the available sound science is distributed over hundreds of disciplines, hence the call for systematic review of what is known and publication of those reviews for critical appreciation as well as practical implementation of what is known rather than what is supposed. One remaining challenge will be those senior managers who are unwilling to inform themselves of the evidence, preferring instead to make decisions based on old prejudices. ■

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