

Does BBS Work?

BEHAVIOR-BASED SAFETY & INJURY REDUCTION: A SURVEY OF THE EVIDENCE

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As behavioral safety continues to gain visibility safety professionals must assess the efficacy of the methods. From a conservative perspective, the question, “Does behavior-based safety work to decrease incidents in every case?” can be difficult to answer. However, sufficient data are available to demonstrate that the approach can accomplish that end. This article also examines a related question: “How can safety professionals make behavior-based safety work better?” Depending on the purpose of the intervention, several suggestions are offered.

Only a few years ago, many safety and health professionals knew little about behavior-based safety (BBS)—a systematic approach to promoting behavior supportive of injury prevention. Today, the media and many professional organizations are giving increased attention to the topic. Safety professionals want to learn more about the way this strategy operates and what it accomplishes—in other words, does it really work?

That may not be the best question to pose, however. This article briefly describes behavioral safety systems and their fundamental elements. It discusses several (of myriad) factors that potentially influence the operation of these methods in a given situation. Facts about its impact on incidence rates are also reviewed to help readers judge the effectiveness of BBS and the appropriateness of posing the question in this fashion.

FUNDAMENTAL ELEMENTS

Although specific behavioral safety systems may vary in form and complexity, at their most basic level they share several common elements:

- 1) Identify (or target) behaviors that impact safety.
- 2) Define these behaviors precisely enough to measure them reliably.
- 3) Develop and implement mechanisms for measuring those behaviors in order to determine their current status and set reasonable goals.
- 4) Provide feedback.
- 5) Reinforce progress.

WHAT QUALITIES DEFINE BBS TODAY?

As any complex effort to prevent threats to people’s wellness, BBS continues to evolve. In many settings, behavioral safety is now an important facet of the total injury prevention package—integrated with areas such as ergonomics, engineering, training, and occupational health and safety management.

To illustrate this integrated aspect, an investigation of a behavior-based strategy to prevent back injuries included pinpointing of specific skills; training maintenance workers in the ergonomics of moving materials safely; bio-feedback on muscle tension; and verbal feedback and rewards for progress in practicing those skills safely (Rosado). In another illustrative case, McCann and Sulzer-Azaroff selected a set of behavioral targets for computer-terminal operators seeking to reduce their risk of injury; these targets were based on recommendations of an occupational health physician (277+).

Safety management was a focus area of a program implemented in a telecommunications plant (Sulzer-Azaroff, Loafmann, et al 99+). Managerial pinpoints included providing weekly safety performance updates to the safety director; participating in the awards program; providing reinforcement to supervisors of departments that met or exceeded goals; helping to develop pinpoints; and encouraging safety suggestions. Safety-related behaviors include not only those of workers, but also those of supervisors, managers and others within the system whose support is crucial.

WHAT DOES “DOES BBS WORK” MEAN?

Beyond its basic elements, BBS can vary from time to time and place to place. Depending on an organization's needs, resources and objectives, each system will have uniquely customized features. So, when potential users ask, “Does BBS work?” it is difficult to provide a definitive answer. Several variables account for the diversity of results one might encounter.

Target Behaviors

Data on efficacy are influenced by the behaviors targeted for change. An intervention's ultimate value can only be as good as the precise behaviors selected. These behaviors must closely relate to improving well-being—in other words, when practiced consistently, they will reduce risks and improve the physical well-being of employees and management. Attempting to change what people say, think or feel is not the same as changing what they do. In addition, the description of a safe practice must be objective, correct and complete (i.e., valid). No matter how much individuals improve the way they perform a task, if key components of that task are irrelevant, omitted or wrong, materials handlers will remain in danger.

Purpose of Intervention

When setting behavioral targets, one must consider the objective of the intervention. The purpose of an endeavor can influence the outcome as well as the manner in which findings are interpreted and reported. The form of evaluation can depend on whether the intervention is part of a controlled laboratory investigation, a systematic field study or a local assessment.

Scientific research attempts unambiguously to sort out competing explanations for results of given interventions. For example, an investigator may study the differential influence of massed versus spaced practice as a method of promoting rapid improvement in the way healthcare workers lift and transfer patients (Alavosius and Sulzer-Azaroff 151+). Program evaluators, on the other hand, may ask whether specific varieties of BBS are effective tools for improving safe practices or reducing injury rates within their organizations (Alavosius *in press*; Krause, et al 1+).

Of course, both researchers and practitioners are concerned that results be as clear as possible. However, the scientist takes far greater care to ensure that competing explanations can be rejected, while the practitioner is usually more concerned with effectiveness and cost-efficiency.

Variations in Application

Basic components, such as identifying and defining safe practices, observing,

and delivering feedback and reinforcement may be applied differently from one program to another, as may supplemental elements. These variations can affect the outcome. (It should be noted that unless each individual element has been carefully isolated from the rest, the extent of any one facet's influence generally remains ambiguous. In practice, these variations tend to be combined and viewed as elements of the total intervention “package.”)

Feedback strategies are one such example. Behavior-analysis textbooks offer diverse definitions for at least 12 different types of feedback (Sulzer-Azaroff and Mayer; J. Cooper, et al). The process of implementing feedback strategies can also vary. For example, Balcazar, et al identified six characteristics of feedback that varied widely between studies (65+). McAfee and Winn commented on these fluctuations when, in a set of studies they reviewed, they found feedback assuming many different forms (7+).

One can also cite variations in how agents define, supplement and implement these components. Consider this brief list of potential variations in the feedback-delivery process.

- Communicate general approval or disapproval in the form of a gesture, a spoken “good,” “okay” or “safe” for one or more safe performance targets, or share more-specific information in words or visually (e.g., graph) to describe what about the performance was safe or unsafe.

- Comment on positive or negative actions or offer constructive suggestions for future behavior, or some combination.

- Offer praise, recognition and/or rewards to individuals or groups.

- Provide one-on-one feedback, or ask peers, supervisors, subordinates, safety personnel, managers or external sources to deliver it.

- Offer feedback publicly or privately to individuals, groups or both.

- Provide feedback verbally, in written form (e.g., graph or digitally), via tangible reward or some combination.

- Deliver feedback according to a fixed or variable schedule (often, seldom or somewhere in-between).

- Combine feedback with goal-setting (interim, final or both).

- Precede feedback by a baseline phase that includes all elements *except* feedback.

Many researchers and practitioners also build-in components beyond identification, observation and feedback. They may incorporate goal-setting (Austin, et al 49+; M. Cooper, et al 219+; Fellner and Sulzer-Azaroff 7+; Reber and Wallin 544+; Reber, et al 51+) or problem-solving (Fellner and Sulzer-Azaroff 7+; Killimett 209+; Krause; Laitinen, et al 35+; Walters 34+). Often, training is a key aspect as well (Sulzer-Azaroff, Fox, et al).

Again, researchers may define these components differently. Goals may be set on a participative or assigned basis (Fellner and Sulzer-Azaroff 3+). Many do not specify how goals were set (Cohen and Jensen 125+). Some install highly structured systems to support problem solving (Krause), while others provide less-formal support (Laitinen, et al 35+).

Variations in the Role of System Coordinator

The role of the individual who designs and coordinates the system may influence results as well. To the applied behavioral researcher, the “does it work” question usually means, “Can a functional (cause-and-effect) relation be demonstrated between a particular set of BBS variables and those that make up safety performance?” Relying primarily on measured changes in rates of safe behavior and perhaps incidents, this researcher approaches the question by tightly controlling those variables thought to affect the targeted outcome measures.

In fact, however, many of the variations in intervention strategies have more to do with achieving experimental control (e.g., establishing inter-rater reliability, using the researcher to observe and provide feedback) than anything else. If the effect of the well-controlled intervention can be shown by using valid, reliable outcome measures, the researcher concludes, “That intervention had a demonstrable effect on safety performance” (in other words, BBS worked in that case).

One example of this is a study designed to explore the impact of a self-generated and/or an external feedback package on changes in the body postures among a small group of volunteer computer terminal operators (McCann and Sulzer-Azaroff 277+). Following the successful demonstration and follow-up assessments, these researchers concluded that their particular BBS package worked for this new class of behaviors. Insufficient resources prevented a wide-scale implementation of the methods to test the finding's validity and generality.

Researchers also want to be as certain as possible that their purported “treatments” actually occur as planned. Consequently, they or trained assistants deliver intervention components instead of internal organizational personnel (Alavosius and Sulzer-Azaroff 151+; Lingard and Rowlinson 243+; Ludwig and Geller 253+; Reber, et al 51+; Saarela 177+). This causes one to question whether the organization could obtain similar results by applying those methods independently.

To the safety professional or business manager, however, the “does it work” question can mean something entirely different. Typically, publishing their results is not a high priority. Nor do they have time to wait for scientific confirmation of the

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results. Immediate decisions must be made to address human and cost issues.

Therefore, managers must make the best judgment based on the information available. Their questions often encompass a wider domain of practical concerns: Will it work in this organization, in this work culture? Will all levels of the workforce buy into the program's concepts? Are the resources available to make this work over the long term? If employees buy-in and resources are available, should the firm expect both immediate and continuous improvement—not only in safe performance, but also in fewer incidents and injuries?

A business-oriented intervention typically calls on the organization's workforce to deliver system components, frequently with each level playing a key role. In these cases, individuals who champion the program provide the necessary training and guidance (Alavosius *in press*; Krause, et al 1+; Krause). That person or group is then challenged to maintain the system's integrity—to verify that it is transpiring as planned.

Variations in Priorities

While the universal goal is to reduce incident and severity rates, other specific outcomes can be affected, depending on the role of the person/group within the organization.

For example, executives, stockholders and directors focus on the bottom line: How much does it cost and what is the return? BBS data are beginning to show short- and long-term savings due to reduced injuries and their associated costs (insurance rates, direct medical, equipment replacement and repair, down-time and lost-time costs).

Of course, figures can diverge, depending on methods used to calculate costs. For example, Veltri offered a direct-cost impact model designed to demonstrate how reducing accidents can lower the degree of operating leverage (67+). Sulzer-Azaroff, Loafmann, et al used a less-formal, more-conservative basis to estimate that in three small departments within a large manufacturing plant, \$55,000 was saved due to reduced injury rates over a six-month period (99+).

Production and quality managers may be concerned with production rates and quality, the amount of time employees would be away from work for training, observing and providing feedback, and

the effects of performing less-expeditiously but more safely. Others may seek change in safety climate or culture.

Individuals with power or control of reinforcers will focus on those outcomes of concern to them. This fact, alone, will influence results because what gets monitored gets reinforced and what gets reinforced is repeated more frequently (Komaki 270+). The opposite is also true—those elements monitored less carefully or ignored tend to diminish.

Variations in Support Structures

The organizational support structures in place also influence long-term results. Many experts agree that the following factors can affect the durability of any BBS effort: clear, visible, ongoing senior executive commitment; institutionalized mechanisms such as actively participating safety/steering committees; data collection (e.g., minutes of meetings; observing and recording numbers of observations conducted, feedback charts up-to-date); feedback routines supporting system maintenance; encouragement of involvement by all personnel (Sulzer-Azaroff and Lischeid 31+).

WHAT ABOUT RESULTS?

What would many consider the bottom-line measure when attempting to answer the "does it work" question? In most cases, incidence rates. Therefore, the authors surveyed literature on BBS to discover what its impact has been on "accidents" or incidence and injury rates.

The Network on Behavioral Safety of the Assn. for Behavior Analysis maintains an exhaustive list of reports on this topic. Eighty-three of those listed describe case demonstrations or experiments that contained hard numerical data. "Promote safe performance" was the main focus of most of these studies.

Many reports omitted correlated data on accident/injury rates, the measure of concern in this article. Several factors may have driven these omissions: 1) the investigation or implementation was conducted over too short a time period to produce meaningful differences; 2) the number of participants was too small to generate meaningful injury data (McCann and Sulzer-Azaroff 277+); 3) the base rate of injuries was too low to be meaningful (Sulzer-Azaroff 11+); and 4) data was kept confidential for business purposes or because researchers had misgivings about

its reliability. It is also possible that some inconclusive or negative incidence/injury data simply were not submitted or accepted for publication. [It should be noted that in most fields involving intervention (e.g., clinical health, social service, psychotherapy), there is potential bias because poor, negative or non-results may not be submitted for publication—or when they are, they are often rejected.]

ARTICLE ANALYSIS

Of the 83 data-based evaluations of behavioral safety programs, the authors identified 33 that reported data on changes in incidence rates. Table 1 provides details of these studies.

Two researchers then independently categorized changes in incidence rates in each study. In all but five cases, entries matched, producing an agreement score of 85.7 percent [(agreements)/(agreements + disagreements) × 100]. Three disagreements occurred because one reviewer converted the reported incidence frequencies to percentage of changes in incidence rates, while the other reviewer did not. In addition, in three cases, one reviewer overlooked a portion of the reported data. Therefore, to portray the results as accurately as possible, the disagreements were discussed and ultimately reclassified.

ANALYSIS OF RESULTS Participants & Settings

The number of participants ranged from five (Haynes, et al 407+; Larson, et al 571+) to 39,664 that one organization tracked (Krause, et al 1+). The number of sites evaluated ranged from single locations to 73 (Krause, et al 1+). Settings included construction sites, grocery distributors, electrical and gas utilities, manufacturing plants, mines, police departments, railroads, shipyards and transit systems. In addition, although most studies were conducted in the U.S., some involved sites in Chile, Cuba, Finland, Hong Kong, Spain and the U.K.

Injury Outcomes

Of the 33 articles reviewed, 32 reported reductions in injuries. In many cases, however, the reporting format differed. Some listed numbers of lost-workdays; others, numbers of accidents. In addition, some accident rates were calculated on the basis of hours worked or miles driven. (In the future, researchers should be encouraged to report rates—not just raw

TABLE 1 BBS Studies Reporting Impact on Injury Rates

STUDY AUTHOR(S)	NUMBER OF PARTICIPANTS	SETTING	REDUCTION IN ACCIDENT/INCIDENT RATES
M. Alavosius (in press)	5 – 500	50 small companies	Lost-workdays per 100 workers: 184 pre-intervention; 111 during; 84 post-intervention (six months) and 58 (12 months).
M.D. Cooper, et al (1994)	540	Construction industry	From 6.33 prior to 3.88 at end; from 3.3 to 0.56 on checklisted items.
D.J. Fellner and B. Sulzer-Azaroff (1984)	158	Paper mill	Significant difference between pre- and during-feedback—from 6.9 percent to 4.9 percent.
F. Fiedler (1987)	500	Mine	Baseline = 226 percent; follow-up two percent over industry average.
D.K. Fox, et al (1987)	1,754	Coal mine	Range: 15 to 32 percent.
D. Harshbarger and T. Rose (1991)	a) 100 b) 350 – 400	a) Bedding b) Footwear	Lost-time accidents a) 95 percent; b) 87 percent.
R.S. Haynes, et al (1982)	100	Urban transit	24.9 percent.
B.S. Karan and R.E. Kopelman (1987)	Not reported	Vehicular and industrial	2.2 percent and 4.0 percent.
J.L. Komaki, et al (1978)	38	Food manufacturing plant	Injuries fell to “. . . less than 10 lost-time accidents per million hours worked, a relatively low number” (pg. 441).
J.L. Komaki, et al (1980)	55	Vehicle maintenance	Decline from 3.0 lost-time injury rate per month preceding to 0.4 during and 1.8 following intervention.
T.R. Krause, et al (1999)	51 to 3,000 per site (39,664 across 73 sites)	73 facilities participating for up to five years	Year 1: 26 percent. Year 2: 42 percent. Year 3: 50 percent. Year 4: 60 percent. Year 5: 69 percent.
H. Laitinen, et al (1998)	300	Engineering workshop	46 percent reduction in absenteeism.
B. Loafmann (1998)	Not reported	Utility company	Treatment group about 78 percent; control group had a 50-percent increase.
L. Lopez-Mena and J.V. Antidrian (1990)	914	Forestry (2) and cement factory (1)	62.8 percent; maintained for three years.
L. Lopez-Mena and R. Baynes (1988)	41	Electrical distribution system	84.9 percent in one setting; 60.8 percent in a second setting.
L. Lopez-Mena, et al (1988)	191	Electrical energy distribution system	34.3 percent.
M. Mattila and M. Hyödynmaa (1988)	100	Building construction	Accident rate per 100 workers at control site higher during (166) and after (55) than experimental site—94 and 47, respectively.
T. McSween (1995)	Not reported	Gas pipeline company	35 percent lost-time accidents.
T. McSween (1995)	Not reported	Chemical company (union-coordinated)	From four to zero the next 18 months.
R. Montero (1996)	Not reported	Industry (general)	“Rate dropped almost to zero.”
M. Näsänen and J. Saari (1987)	32	Shipyard	50- to 75-percent reduction in accidents.
D. Petersen (1984)	Not reported	Railroad	“Experimental groups had fewer injuries than control [groups].”
R.A. Reber, et al (1984)	105	Farm machinery manufacturing	53.83 percent.
R.A. Reber, et al (1990)	44	Manufacturing	50 percent.
K.L. Saarela (1989)	2,800	Shipyard	Modest, non-significant reduction in accident frequency. This intervention involved a poster campaign, not a full behavioral program, and feedback to supervisors.
K.L. Saarela (1990)	24	Shipyard	20 percent during; about 40 percent after.
K.L. Saarela, et al (1989)	58	Shipyards	No significant differences (poster campaign; general subject feedback).
K.L. Saarela (in press)	>900	Shipyard	60+ percent.
J. Saari and M. Näsänen (1989)	24	Shipyard	25-percent reduction in accidents; 30-percent reduction in injuries.
R. Schwartz (1989)	110	Grocery distribution workers	39.4 percent.
M. Smith, et al (1978)	44	Shipyard	Average decrease in eye injuries of 7.48 per 100 workers; control group average reduction of 1.16.
B. Sulzer-Azaroff, et al (1986)	140	Paper mill	From 19 recordable incidents during baseline to two after feedback given for three behaviors.
B. Sulzer-Azaroff, et al (1990)	225	Telecommunications parts manufacturing plant	Number of OSHA recordables dropped by 17 from prior to during intervention; lost-time from 14 to 1.

numbers—as well as the basis for the rate calculation.) Differences in experimental designs also affected data reports. Those using group comparisons reported information on statistical significance, while those using repeated measure or intensive designs (e.g., multiple baselines) relied, according to convention, primarily on graphic presentations. To simplify the descriptive analysis for this article, whenever feasible, average changes were calculated from pre- to during and/or post-intervention.

To illustrate the difficulties encountered in drawing unambiguous conclusions about the efficacy of a given BBS intervention, consider this example of Saarela's (in press) thwarted efforts to maintain tight experimental controls during an intervention at a shipyard.

Following a two-hour training seminar, safety teams from each production department identified departmental safety problems, then set goals, solved problems, implemented improvements, monitored results and provided feedback. According to the original research plan, only three departments were to be involved, with others joining later; however, when those not included saw the results, they demanded immediate participation.

The success of those tactics was underscored when results were analyzed. By the time the 900 workers in all 10 departments were actively participating in the process, the shipyard's accident rate was more than halved. Subsequently, the program was continued under the coordination of the shipyard's safety personnel.

Beyond experimental-design issues, other cautions must be considered. For example, how much room remained for improvement? Sites with high injury rates have a larger potential for improvement than those with low rates. One must also consider problems in the reliability of reporting of incidence rates.

THE REAL CHALLENGE: HOW TO MAKE BBS WORK BETTER

Despite the limitations noted, the data gathered support the conclusion that BBS systems appear to have helped reduce injuries on many occasions. In light of that finding, the next question is, "Given these particular purposes and circumstances, how can this organization make BBS work as well as possible?"

The answer depends on the main purpose of the intervention. If it is research seeking to demonstrate a clear causal relation between a given class of behaviors and a particular change method, then finely honed, tightly controlled experiments must be designed. These include:

- valid, reliable measures of performance and side effects, under baseline, treatment and afterward;
- change strategies that hold the most

promise for attaining improvement in behaviors of concern within a given context;

- data which demonstrate that the experiment was conducted as described.

However, when the purpose is to implement a process in the most-effective, efficient way within a given organization, one must look beyond the basics of the technology itself to organizational issues that impact how the technology is implemented. Are mechanisms in place to sustain longevity? Is the method compatible with the site implementing it? Does a reasonable balance exist between objectives and resources?

Others share a similar perspective. After evaluating the outcomes of 41 efficacy studies of safety training, Johnston, et al concluded that effective training programs shared four common characteristics: 1) needs assessment; 2) program development; 3) goal setting; and 4) knowledge of results through feedback (147+). In a related analysis, Hidley identified seven factors critical to the success of BBS implementations:

- 1) Use a process blueprint characterized by structure and rigorous implementation, while allowing flexibility to adapt technologies to site-specific needs.
- 2) Create buy-in through communication. Highest levels of leadership, management and labor must be committed to improvement—in both actions and words.
- 3) Demonstrate leadership and active support for the change process.
- 4) Ensure implementation-team competence through training and follow-up.
- 5) Provide action-oriented skills training in a structured, safe environment in which trainees can practice new skills.
- 6) Use feedback data based on safe behavior under the control of employees to remove barriers.
- 7) Ensure that adequate technical assistance (internal or external) is available from individuals who make practical, feasible and well-considered recommendations for process success (30+).

A similar list describing a quality behavioral safety system was detailed in a survey of behavioral safety specialists (Sulzer-Azaroff and Lischeid 31+). That list included: well-defined, correct, relevant target behaviors; worker participation; managerial involvement; observational data collection; training/education; positive reinforcement; interventions based on sound behavioral technology; behavioral feedback; and organizational systems structured to support the effort.

CONCLUSION

The studies evaluated suggest that despite some reservations about how accurately the published literature reflects reality, in many cases, incidence rates have been reported to decline following implementation of BBS system. Presumably the

growing interest in this technology is justified by the gains many companies have reportedly achieved. Most essential to those gains are the training, organizational, managerial, follow-through and other factors discussed. To ensure that the system works most effectively, these factors, along with the findings generated from ongoing and future research, should be considered when designing any BBS system. ■

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