Pyramid Power

A New View of the Great Safety Pyramid

By Dave Rebbitt

IN BRIEF

- **Safety pyramids date back more than 80 years. Some interesting discussion exists on whether H.W. Heinrich's safety pyramid has meaning today. Some follow the pyramid and its ratios with zeal, basing entire safety systems around them. Others question not only the ratios but the entire concept.**
- **The validity of these first safety pyramid ratios is doubtful, yet the original concept has been overlooked.**
- **Using ratios to measure and manage an organization's safety performance is an old idea that may still have merit.**

In the safety and health field, no image is more imprinted than the pyramid or triangle. The safety triangle has attained cult-like status since its introduction more than 80 years ago. It has been interpreted, reinterpreted and many have made it their own with custom modifications. The triangle became a three-dimensional pyramid and model of what safety is supposed to be all about.

The safety pyramid has a long history dating back to 1931 and H.W. Heinrich with his pioneering book *Industrial Accident Prevention: A Scientific Approach*; his image and concept have stood the test of time. Today, it is easy to find examples or variations of Heinrich's triangle. There is some interesting discussion on whether it has any meaning today. Some follow the pyramid and its ratios with zeal, basing entire safety systems around it. Others question not only the ratios but the entire concept.

After all, in 1931 the world was a different place. The new Empire State building was just completed with an airship docking mast, Al Capone was convicted of tax evasion and the U.S. adopted "The Star Spangled Banner" as its national anthem.

Pyramids, Triangles & Ratios

With the original triangle, Heinrich illustrated the relationship of serious incidents to less serious ones by putting the values 300-29-1 into a triangle (Photo 1). One serious injury was related to 29 minor injuries and 300 noninjury events. Heinrich used incident data collected from an insurance company and analyzed it to determine the causes of incidents. He published his book claiming that 88% of incidents were caused by the unsafe acts of people, 10% were caused by unsafe conditions and 2% were not preventable.

Unfortunately, Heinrich's original work and data are not available and no one has been able to verify or categorically refute his findings. His definitions of serious or minor injuries are also unclear. Today, many believe that Heinrich's work was important, but superficial, and the numbers in the triangle questionable at best. While the message of the ratio may have been lost over time, the 88% figure has, similar to the triangle, been elevated from concept to often quoted fact. The figure has even been rounded up to 90%, and unsafe acts have become unsafe behaviors in the behavioral safety movement. In the first edition (1931) and third edition (1950) of his book, Heinrich indicates that the causes of minor and major incidents are generally the same. In the third edition, he states that the repetition of noninjury incidents inevitably leads to major incidents (Manuele, 2002). Some 80 years on, Heinrich's legacy remains uncertain.

Perhaps the last we would have seen of the triangle would have stopped with Heinrich, but in 1966 Frank Bird and George Germain published their book *Damage Control*, and proposed a new triangle and new ratios. This was followed by U.K. studies in 1972 by Fletcher who studied 50 plants owned by one multinational company that operated in 12 countries. In 1975, Tye completed a study of incidents from reporting at 2,000 enterprises (Health & Safety Executive, 1994). U.K. national data were used in another study published in 1999.

All of these studies used large groups and expressed the results in triangles or pyramids (Table 1). Other studies conducted in the U.K. also looked at Labor Force Survey data to provide a ratio in 1990 and in 1995-96 (Table 2, p. 32).

It is clear from the U.K. data that the ratios are shifting, they may not be constant and they may even vary by organization. It is also possible that the definitions used for minor and major injuries vary. Bird and Germain's (1996) book, *Practical Loss*

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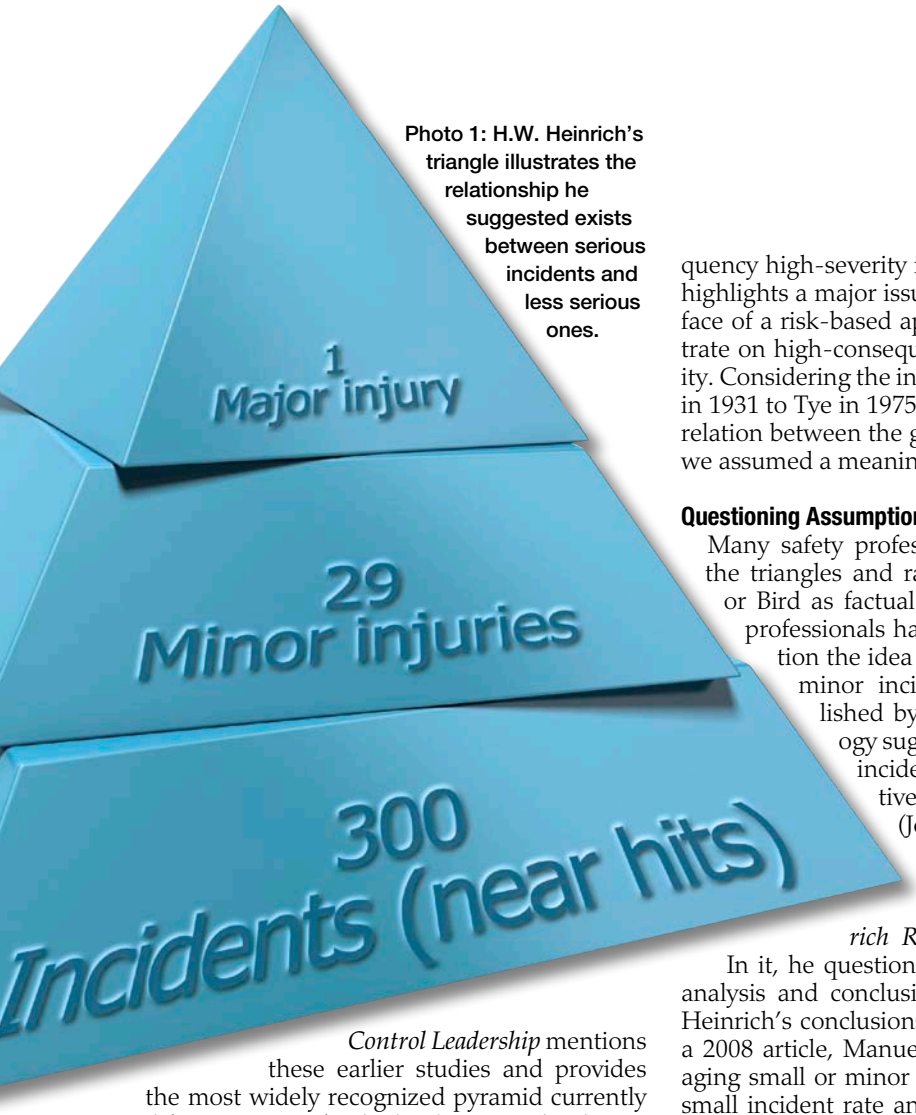

Photo 1: H.W. Heinrich's triangle illustrates the relationship he suggested exists between serious incidents and less serious ones.

Control Leadership mentions these earlier studies and provides the most widely recognized pyramid currently used (Figure 1, p. 32). The book asserts that by reporting, investigating and preventing near-hits or minor incidents we can shrink the pyramid and proportionally reduce the number of serious incidents (p. 6).

This is an important concept as it reinforces statements made by Heinrich and remains embedded in safety training and thought even today. Even fairly recent academic papers tout near-hit reporting as a way to reduce more serious incidents. Oktem (2002) states, "Therefore, it has been recognized that by focusing on minor incidents it is possible to reduce the probability of having major accidents." In 2011, a statistical analysis and study concludes that "fatal accidents are inevitable" and notes that in accordance with Heinrich's principles "fatalities cannot occur without a foundation of less severe incidents" (Collins, 2011, pp. 27-28).

So, reducing the number of minor incidents to reduce the likelihood of a major incident intuitively makes sense. Near-hit reporting, and concentrating on behaviors and minor hazards can be time-consuming but it promotes compliance with legislation and internal systems. Pyramids have even appeared integrating behavior, procedures, training and other aspects as necessary for the prevention of injuries (Fulwiler, 2002) (Figure 2, p. 33).

Concentrating on low-severity incidents that occur with a higher frequency can reduce low-frequency high-severity incidents. Stating it this way highlights a major issue. Such thinking flies in the face of a risk-based approach that would concentrate on high-consequence risks as the first priority. Considering the incident studies from Heinrich in 1931 to Tye in 1975, we can see a recurring correlation between the groups of incidents, but have we assumed a meaning where there is none?

Questioning Assumptions

Many safety professionals still cling tightly to the triangles and ratios presented by Heinrich or Bird as factual and absolute. Other safety professionals have begun to seriously question the idea of focusing on near hits and minor incidents. A 2002 study published by Behavior Science Technology suggests that focusing on minor incidents was definitely not effective at reducing major incidents (Johnson, 2011). A major challenge to the status quo was made in 2002 when Fred Manuele published *Heinrich Revisited: Truisms or Myths*.

In it, he questions Heinrich's data gathering, analysis and conclusions. Manuele (2002) terms Heinrich's conclusions misguided or mistaken. In a 2008 article, Manuele makes it clear that managing small or minor incidents only improves the small incident rate and does not affect the major incident frequency; he terms Heinrich's assumption a myth (p. 34).

In 2011, Manuele took serious issue with Heinrich's pyramid and ratios myths. It was clear that Heinrich's scientific approach was not scientific at all. In a well-reasoned argument, these assumptions were called into question (Manuele, 2011). The research on which Heinrich, or Bird and Ger-

Table 1
Ratio Studies

	Heinrich, 1931	Bird & Germain, 1969	Fletcher, 1972	Tye, 1975
Fatal				1
Major injury	1	1	1	
Minor injury	29	10	19	3
First aid only				50
Property damage		30		80
Noninjury	300	600	175[a]	400

Note. *Data from* The Costs to the British Economy of Work-Related Accidents and Work-Related Ill Health, *by Health and Safety Executive (HSE), 1994, Sudbury, U.K.: HSE Books.*

[a]*The value of 175 is for "damage only and near miss"*

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main based their conclusions is simply not available for review. Manuele was unable to completely refute these earlier assumptions or theories, as pointed out by Paul Difford (2012) in a reply to the article. While the argument was sound and well reasoned, Difford points out that no research or evidence exists that demonstrates Heinrich was incorrect.

The key assumption that concentrated on minor injuries was not disputed by Difford, who himself disputes the idea that a reduction in minor injuries will result in a proportional reduction in major ones. In fact, Difford also questions the common-cause assumption made by Heinrich that all incidents share common causes. Additionally, he comments that any universal ratio would not be applicable in any specific industry or company. He believes Heinrich's key message—looking for common causes as a function of investigation—has been missed, and the purpose of the triangle and ratios misunderstood (Difford, 2011, pp. 15-19).

More recently, research has called into question not only the assumption that unsafe acts are the primary cause of incidents, but that any sort of relationship between fatality and injury rates exists. Since the 1990s, injury rates have continued to fall at a much more rapid rate than fatalities. This would really make any universal ratio, such as those proposed in earlier studies, of limited use. Poor injury reporting is pointed to as the primary reason for the break in the traditional relationship between fatalities and injuries (Lessin & McQuinston, 2013). In construction, an inverse correlation (e.g., falling injuries would mean rising fatalities) was also found between injuries and fatalities. (Mendeloff & Burns, 2013).

For many, the pyramid and its ratios seem thoroughly debunked. In his latest book, Manuele (2013) terms Heinrich's ratio a work of fiction (p. 159). If this is the case, what use are these ratios and pyramids? Is it time to rip down the posters and rid ourselves of this vestige of the past? Concentrating on near-hit incidents will not reduce the frequency of major incidents, so were these pioneers wrong?

Table 2
U.K. Labor Force Surveys

	Labor force survey, 1990		Ratio to major	Labor force survey, 1995-96		Ratio to major
Fatal	1			1		
Major	280	7.83%		207	4.74%	
Absence 3 or more days	1,320	36.91%	5 to 1	1,402	32.13%	7 to 1
Minor, 3 or fewer days	1,975	55.23%	7 to 1	2,754	63.11%	13 to 1
Totals[a]	**3,576**	**99.97%**	**12 to 1**	**4,364**	**99.98%**	**20 to 1**

Note. *Percentage totals may not equal 100% due to rounding. Total ratios are the ratio of major injuries to all others combined. Data from* The Costs to the British Economy of Work-Related Accidents and Work-Related Ill Health, *by Health and Safety Executive (HSE), 1994, Sudbury, U.K.: HSE Books; and* The Cost to Britain of Workplace Accidents and Work-Related Ill Health in 1995/96, *by HSE, 1999, Sudbury, U.K.: HSE Books.*

The Lost Secret

Those pioneers found something important and, as many have implied, the message has simply been lost as we seize on the symbol and ratios, but not their meaning. U.K. studies and an article by Manuele (2004) both mention that industry-specific ratios exist. Manuele rightly states that these have limited value. Some industry examples comparing injury to noninjury events appear in Table 3.

Industry-specific ratios can vary widely. In the U.K., the finance industry was 1 to 0.6 where we see construction at 1 to 64 (HSE, 1999). Some U.S. examples comparing the ratio of lost workday cases (LWDC) to total injuries and illnesses showed a variation from a low of 1 to 1.38 to a high of 1 to 2.70 (Manuele, 2004, p. 22). Each industry has different hazards, training levels and task complexity. Considering the basic concept that more near hits occur than injury incidents, and more minor events result in loss than major ones, we know this is indeed the case. Attempts to apply a ratio or pyramid on a wide scale are not doomed because the concept is wrong, but because of the wide variation among industries and within individual companies.

Figure 1
Bird & Germain's Pyramid, 1996

At the individual company or divisional level, modern safety professionals can utilize this important concept. Clearly we do not expect fatalities or major incidents, but we can utilize the injuries, property damage and noninjury/loss incidents to manage the safety system.

Replacing the Traditional Pyramid

All safety departments collect loads of data. Most companies with 500 or more employees can generate sufficient data for basic analytics. Everyone knows what their injury rate is and how that is progressing, but what about the ratio? Historical data can be used to build a model to determine what is normal for a company. In a mature system, this will enable identification of control limits or development of leading indicators on performance. Using ratios can identify trends and give early warning that something is outside the normal expected parameters. A good example is a behavioral observation program. The ratio of or interactions that are positive reinforcement versus corrective or coaching in nature can be a good indicator of issues meriting further investigation. Building a pyramid on a smaller scale can be useful.

If a company uses contractors or subcontractors, looking for a ratio in the statistics provided by them would also help identify potential issues such as incorrect or poor reporting and misclassification of incidents. Ratios can also help when comparing similar contractors.

Even a more risk-based approach to incident investigation still goes back to the original concept of looking for common causes and trends on error to dictate effective preventive action. We no longer need to worship the pyramid, but only look to the message it hides. The early pioneers worked in a world where the very idea that incidents could be prevented was radical. Their concepts and their work have brought us to a safer workplace and a more sophisticated understanding of workplace safety. We should not just dismiss these concepts or assumptions but understand what they mean to the profession today. The figures published by the pioneers were meaningful for them, but forward-thinking professionals must make their own to keep things relevant and effective. Using 12 months of data on a rolling basis can help reveal trends in a company's safety performance when compared to historical data.

Some ratios with lagging data that may prove useful are:

- Ratio of LDWC to other injuries. This ratio would track severity and claims management efficiency.
- Deconstructing the days away restricted or transferred rate into a ratio of days restricted to days away can also provide a good indicator of the effectiveness of claims management and provide a better picture of actual severity. Who is to say that a case involving 6 days away from work is less severe than one involving 100 days of restricted work?
- If there is a functioning behavioral observation process, the ratio between observations conducted and all incidents may provide insight into the effectiveness or quality of the observations.

Leading indicators can also provide some useful ratios:

- inspection action items ratio to number of incidents;
- ratio of corrective or coaching behavioral observations to ones that only provide positive reinforcement;
- ratio of near miss or hazard reports to all injury and property damage incidents can be helpful in understanding how well field reporting actually is working in various facilities or sites.

Figure 2
Conoco Phillips Marine Study Pyramid, 2003

Table 3
Industry Ratios

	Food manufacture	Construction	Oil production	Hospital
Reportable injury	1	1	1	1
Other injury	5	56	4	10
Noninjury	48	3,569	126	195
Ratio	**1:24**	**1:64**	**1:25**	**1:18**

Note. *Data from* The Costs to the British Economy of Work-Related Accidents and Work-Related Ill Health, *by Health and Safety Executive (HSE), 1994, Sudbury, U.K.: HSE Books.*

Recognizing that organizations have their own pyramid can help better manage risk and identify trends.

To some, these are not new measures or ideas. In fact, the TRIR is a ratio expressed as injuries per 100 employees. Using ratios that are based on lagging indicators can be predictive of future trends and assist in strategically focusing efforts where they can have the most benefit. Recognizing that organizations have their own pyramid can help better manage risk and identify trends.

Conclusion

Finding the right metrics to fit the organization and its expectations can be difficult. Using ratios to measure and manage the organization's safety performance is an old idea that still may have merit. A recordable injury rate should not be the only factor that safety professionals use as a performance indicator. Organizations are unique and may benefit from a unique measurement approach that can help identify weak areas or changing issues within the functioning safety system.

It is important that those with system or program responsibility have metrics in place not only to determine injury trends but to determine if the system is functioning within expected parameters. Setting upper and lower control limits around the right metrics can assist in making a system more proactive and less reactive.

By using historical incident data and building ratios, additional metrics can be identified and presented to the management team. Selecting additional metrics that have more relevance to the organization can assist in integrating safety into the organization's strategic planning. Modern safety professionals will see the strategic goal for the safety system; the goal should not be just to reduce injuries, but to continuously improve the system by using meaningful metrics that reveal more about how the system is actually performing.

In 1961, Heinrich was named an ASSE Fellow, the Society's highest honor, and a well-deserved one for a man who continues to have tremendous influence on safety professionals today. It remains up to us to use the concepts, but let go of the assumptions. **PS**

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