THINKING SENSIBLY ABOUT INJURY PREVENTION AND SAFETY

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Abstract

In spite of considerable media, educational, conference, and medical attention, gymnastics' most serious problem remains – injury. Programs for injury prevention, recovery, and treatment have been proposed often, implemented haphazardly and have shown little merit with respect to actually reducing injury incidence and rate. The countermeasures involved in injury prevention include a variety of tools ranging from apparatus specifications to the attitudes of administrators, coaches and athletes. Sadly, if any one of the countermeasures is inadequate an injury is a likely result. The relative risks of poorly constructed and implemented safety programs, poor training and a lack of imagination, and simple denial of risk are among the most serious threats to attaining and maintaining reduction of injury incidence and rate. Five questions are proposed as a model for injury prevention and safety involving ideas that have been gathered from both safety and security literature. The ramifications of these questions are discussed and their potential use in identification of countermeasures is postulated.

Keywords: *gymnastics, training, risks.*

INTRODUCTION

Gymnastics' most serious problem has been and remains - injury (Sands, 2000a). Injury is certainly harmful, and all safety programs involve the prevention of unintentional threats of harm. Thus, safety and injury prevention are linked by intentional countermeasures that can be used to prevent a threat of injury, prevent the likelihood of an injury, and reduce the damage caused by an injury. In this paper we would like to focus on the similarities and use some of the ideas that are found in security programs to augment our thinking about safety programs, and a safety culture for gymnastics.

Among the various threats of harm, safety programs and systems are easier to understand and implement than security programs and systems because security involves an "attacker" who is attempting to defeat security measures and thereby cause harm, gain access, lower morale, instill fear, and/or maximize these effects in a population. Safety programs do not involve an opponent who is trying to defeat injury prevention and reduction measures. Safety measures are defeated, or non-existent in some circumstances, and result in harm that may be every bit as devastating as a security breach, but the harm is based on unforeseen

circumstances, failure of imagination, lack of appreciation of the presence and magnitude of risks, and/or simple laziness. Both security and safety involve alarms. Security may involve physical alarms while safety involves alarms of reasoning and imagination. For example, if an athlete is allowed to do X, the risks to the athlete and others may be Y_1, Y_2, Y_3, and so forth. By coupling actions with consequences, both desirable and harmful, we can be prepared to reduce the probability of harm. Too often, people simply ignore risks by taking a "no-news-is-good-news" mentality until something bad happens that results in them finally noticing a problem that had been there - sometimes for years. What we often see was summarized by Gerstein (Gerstein, 2008):

"However, the alarms were ignored by those who had the power to disregard them. Why? How do smart, high-powered people, leaders of global corporations, national institutions, and even nations get it so wrong", p 1.

That highly ranked and powerfully placed people make mistakes is not surprising in our modern complex world. What is surprising is how often the obvious evidence, clear alarms, missed cautions, and ignored common sense permeate so much of acrobatic sport. All too often risks are ignored until it's too late: "Nevertheless, many high-powered people had remained unconvinced that we were at risk, so nothing was done – until it was too late for anything but damage control" (Gerstein, 2008) p 3. In gymnastics, what are some typical risks that are too often ignored?

1. Pits that are not filled to the top with foam, are too shallow, or not padded properly (Allen, 1985; Finkel, 2001; Isabelle & Jones, 1990; Klaus, 1985; Klaus & Allen, 1990; Sands, Cunningham, Johnson, Meek, & George, 1991a; United States Olympic Committee, 1995; Wettstone, 1979).

2. Mats that are old and have lost both their resiliency and absorbency (Copeland, 1985; Cunningham, 1988; Gatto, Swannell, & Neal, 1992; Gros & Leikov, 1995; Salvo & Copeland, 1990; Sands, Cunningham, Johnson, Meek, & George, 1988; Sands, Cunningham, Johnson, Meek, & George, 1991b; Shields & Smith, 2009).

3. Apparatus floor cables that are frayed or otherwise damaged (Federation Internationale de Gymnastique, 1989; Geist, 1985; Mills, 1998; Niu, Lu, Xu, Liang, & Li, 2000).

4. Inadequate matting for the nature of the skill being performed (Caine, Cochrane, Caine, & Zemper, 1989; Caine, Lewis, O'Connor, Howe, & Bass, 2001; Caine, 2002a; Caine, 2002b; McNitt-Gray, Yokio, & Millward, 1993; McNitt-Gray & Yokoi, 1989; McNitt-Gray, Yokoi, & Millward, 1994; Sands et al., 1988; Sands & Drew, 2007; Wilson, Millhouse, Swannell, & Neal, 1986; Wilson, Neal, & Swannell, 1989).

5. Gymnasts that attempt skills that are too advanced for them or sometimes the coach is seduced by the very talented athlete into thinking that the athlete cannot make a serious error (Malmberg, 1985; Moskovitz, 1990; Moskovitz, 1993; Sands, 1990a; Sands, 1990c; Whitlock, 1989a; Whitlock, 1989b).

6. Gymnasts that are not properly conditioned to withstand the stresses and strains of training and competition (Sands, 1985a; Sands, 1990b; Sands, Major, Irvin, Lemons, & Abramowitz, 1991; Sands & McNeal, 1997).

7. Horseplay – all one needs to see dangerous horseplay is to watch gymnastics videos on YouTube™ , specifically those that show people performing skills without any visible adult supervision and narrowly missing injury (Russell, Quinney, Hazlett, & Hillis, 1995; Sands, 1990b; Sands, 1993; Sands, 1994a; Sands, 1994b; Sands, 2000b; Sands, Dunlavy, Smith.S.L., Stone, & McNeal, 2006; Sands, Irvin, & Major, 1995; Sands & Major, 1991).

8. Poorly designed apparatuses that do not meet the needs of the gymnast that uses them (Daly, Bass, Finch, & Corral, 1998; Hartfel, Reeves, Munkasy, & Smith, 1991; Kawata & Murayama, 1988; Leglise,

1999; Sands, 1985b; Sands, 2000a; Sands & George, 1988; Sands et al., 2005).

9. Unwarranted and disruptive parental intrusions (Bungum, Wald, & Martin, 2000; High Performance Productions, 1997; Malina, 1986; Malina, 1997; Power & Woolger, 1994; Weiss & Ebbeck, 1996; Weiss & Hayashi, 1995; Whelpley, 1995)

10. Too much confidence in spotting (Boone, 1979; Daly et al., 1998; George, 1988a; Mitchell & Longdon, 1985; Sands, 1996; Sands, 2000a; Whitlock, 1992).

11. Poor spotting skills (Cowan, 1987; George, 1988b; Hage, 1983; Milem, 1990; Mitchell & Longdon, 1990; Whitlock, 1989c)

12. Practicing while fatigued (Kolt, 1992; Pettrone & Ricciardelli, 1987; Sands, 1987; Sinyakov, 1984; Vain, 2002).

13. Practicing while injured. (Aldridge, 1987; Caine et al., 1989; Caine, Howe, Ross, & Bergman, 1997; Caine, Lindner, Mandelbaum, & Sands, 1995; Daly et al., 1998; Daly, Bass, & Finch, 2001; Hadjiev, 1991; Steele & White, 1986)

14. Poor understanding of the mechanics of safe skill performance (Sands & Stone, 2006; Stone, Sands, & Stone, 2004).

15. Too many competitions (Issurin, 2008; Issurin, 2010), and the modern international competitive format which does not allow the athlete's personal coach to attend and be on the competitive floor.

16. And, many more.

The length of the litany of items listed above should cause one in acrobatic sports to pause for a moment and realize just how potentially dangerous the activities are. Moreover, so little has actually been done to develop countermeasures for training and performance safety. One of the most important countermeasures is mats (ASTM Designation: F 1162-88 (Reapproved 1999), 2000; ASTM Designation: F 1676-96, 2000; ASTM Designation: F 1931-98, 2000; ASTM Designation: F 381-99, 2000; Copeland, 1985; Copeland, 1990; Copeland, 1999; Jacki, 1977; McNeice, 1981; McNeice, 1989; Mills, Pain, & Yeadon, 2006; Perez-Soriano et al., 2010; Salvo & Copeland, 1990; Sands et al., 1988; Sands et al., 1991b; Shields & Smith, 2009; Wilson et al., 1986). Mats serve much like a trapeze artist's net. Generally, when all other countermeasures have failed; mats are the final opportunity for protection. As such, mats should receive a great deal more attention than they have. For example, drop tests are still the gold standard for mat testing, the dropping of a known mass onto the mat and measuring accelerations and indentation. Gros and Leikov (Gros & Leikov, 1995) have questioned the effectiveness of mats on feet-first landings, McNeice (McNeice, 1981; McNeice, 1989) has questioned mats relative to material characteristics and impact, and Sands and colleagues (Sands et al., 1988; Sands et al., 1991a; Sands et al., 1991b) have questioned the efficacy of mats and pits depending on where the gymnast lands in a simulated unplanned fall on mats and absorptive characteristics of a foam pit. Some investigators have endeavored to test mats in much the same way as automobile manufacturers test vehicles, but given the expense of an instrumented crash mannequin and the specialized nature of its use, drop weights and other substitutes have been the norm. Moreover, rarely do human impacts with mats gain much attention (Sands et al., 1988; Sands et al., 1991a; Sands et al., 1991b), but when human impacts are investigated the primary approach is on controlled landings on the feet (McNitt-Gray, 1991a; McNitt-Gray, 1991b; McNitt-Gray, 1999; McNitt-Gray & Anderson, 1993; McNitt-Gray et al., 1997; McNitt-Gray, Munkasy, Welch, & Heino, 1994a; McNitt-Gray, Munkasy, Welch, & Heino, 1994b; McNitt-Gray, Requejo, Flashner, & Held, 2004; McNitt-Gray et al., 1993; McNitt-Gray & Yokoi, 1989; McNitt-Gray et al., 1994). The studies performed by McNitt-Gray and colleagues clearly indicate that the gymnast uses various neuromuscular strategies to accommodate descent distance and landing surface. These excellent studies have not been transferred

to the most injurious landings which involve unplanned falls that do not land on the feet.

Inadequate, inappropriate, and self-training are collectively responsible for many injuries and require their own set of countermeasures (Sands, 1987; Sands, 1990a; Sands, 2002). All of these require that those who are highly ranked and powerfully placed in administrative/leadership roles be fully risk-aware, and utterly committed to a safety. This commitment must be present in spite of limited funds, pressure from young people and parents to progress too fast, little experience and knowledge of the risks inherent in an activity, a reckless quest for increased difficulty, and elevating spectacle at the expense of preparation, training, conditioning, fatigue control, facilities, and other factors. Self-training has most recently risen to a level of concern as various examples of "street-acrobatics" (e.g., Parkour) have become popular among youngsters in extreme sports (Johnson, 1985; Lloyd, 2006; Miller & Demoiny, 2008; Patel & Luckstead, 2000; Victorian Injury Surveillance System, 1996).

Spotting, or the act of physically assisting and/or manipulating the athlete's body through space or through the movement, is considered a potent injury countermeasure (Boone, 1979; George, 1988a; George, 1988b; Hage, 1983). When spotting is performed during a planned movement, the task of the spotter is often quite simple and easy to learn and perform. The spotter and the gymnast often perform a sort of spotting choreography with the resulting "juggling" of the athlete's body with little threat of a fall. Unfortunately, during an unplanned fall, spotting is rarely effective. Human reaction and movement time present serious, unavoidable and immutable constraints on how much a human spotter can do to protect a falling gymnast (Daly et al., 1998; Gebauer, 1988; George, 1988b; Sands, 1996; Sands, 2000a). The only experimental work available on spotting was performed by Gebauer in conjunction with a vault accident and resulting litigation. The primary finding was that there was far too little time for a spotter to impose any meaningful movement or safety maneuver with a falling gymnast. Spotting, while an important aspect of acrobatic sport, is not a panacea.

We are, by nature, not very good at estimating the magnitude of risk. We seem to adjust our ideas of risk based on our personal experiences rather than evidence-based information. "Careful studies show that when we are asked to assess likelihood, we often answer with a subjective assessment of how well the story fits with our expectations: The degree of narrative fit rather than our objective assessment of the actual likelihood determines our ultimate probability judgment" (Gerstein, 2008), p 25. Even expectations of gain and loss influence our decisions about risk. "The primary – and non-intuitive – finding is that people are risk-averse when anticipating a gain but risk-seeking when anticipating a loss. In other words, when people feel confident that they are going to be successful in some venture or investment, they will forgo the uncertain possibility of additional gains in exchange for greater certainty. On the other hand, if they anticipate a loss, they will often double down their bets in the hope of getting even" (Gerstein, 2008), p 30. Risk taking and risk aversion are also modified by whether we choose to take the risk or if we have no control. "People underestimate risks they willingly take and overestimate risks in situations they can't control. When people voluntarily take a risk, they tend to underestimate it. When they have no choice but to take the risk, they tend to overestimate it" (Schneier, 2006), p 27. To make a final effort at amplifying how we do at estimating risk, note that: "More people are killed every year by pigs than by sharks, which shows you how good we are at evaluating risk" (Schneier, 2006), p 29. Gymnastics often displays these propensities in coaching and athlete choices to perform a skill "one most time," attempt skills that are beyond the gymnast's safe capacity, and replace sound progressions with apparatus-related countermeasures –

like foam pits (Finkel, 2001; Malmberg, 1985; Sands, 1990a; Sands, 1990b; Sands, Cunningham, Johnson, Meek, & George, 1991; Whitlock, 1989).

Given that our intuitions and judgments are often wildly off or misplaced, how can a coach, administrator, parent, and athlete do a better job of managing risk? Common sense tells us that. "Threats determine the risks, and the risks determine the countermeasures" (Schneier, 2006), p 21. Moreover, no safety program is foolproof, but neither are all safety programs equal. There are poor practices and excellent practices. Each is largely context dependent, but within each context there are ways to arrive at a tentatively "best" decision. In any litigious society, it is incumbent on everyone in gymnastics, from those who make the rules to those who follow the rules, to those who evaluate the performance by the rules, to be aware of how to implement a safety program and establish a safety culture that permeates all aspects of gymnastics learning and performance.

Five Questions to Design and Implement a Safety Program and Culture

The problem of safety implementation can be tidily collected in five questions or ideas. The answers to these questions are sometimes complex and sometimes obvious, but careful consideration of each layer of questions and answers – no matter how tentative - will help prepare gymnastics administrators and coaches to develop and implement a safety culture and program.

There are a few prerequisites to a safety program. First, there has to be an institutional commitment. "Without an institutional recognition of risk, an emphasis on safety is unlikely, and in the absence of a focus on safety, it is impossible to achieve it" (Gerstein, 2008), p 103. In short, safety has to be on the minds of every person every day, and every moment, particularly those in leadership positions. Much of the implementation of a safety culture is the recognition of threats or hazards that are to be avoided and a vigilance of observation and reasoning in evaluating every individual circumstance for the presence of risk. "Without a rigorous, multilevel process for trapping hazards, the likelihood of an accident at some point is 100 percent." (Gerstein, 2008), p 124.

Question 1. What assets are you trying to protect?

"Assets" may sound a little cold when thinking about your primary asset which is the athlete. However, the term is still appropriate because there are often needs to protect non-athlete assets in order to protect the athlete later. For example, the coach may need to protect parents from themselves because some like to try the skill that their youngster is working on. For example, injuries to parents have occurred due to the parent jumping into a foam pit. While such acts are often seen as fun; and gymnasts land in pits all the time; a weaker, older, heavier, less skilled, and perhaps overzealous parent trying the same skill can result in injury because the parent has never been instructed and practiced in how to land in a pit. An injured parent can turn suddenly into a litigious adversary because of the injury and regardless of how well his/her youngster is doing in gymnastics. Another asset is a coach. There are some spotting techniques that are more helpful than others. Moreover, coaches have often sprained thumbs and torn their biceps tendon when trying to catch a falling gymnast.

There are other assets to be protected such as: college or national team scholarships, your gym's reputation, your exposure to litigation, the competitiveness of your athletes, and the long-term career prospects of the athletes. At the very first step you need to determine precisely what it is you're trying to protect. Although inherent in coaching, one of the most difficult aspects of the first question is that the specific risks that a given athlete may

face throughout a workout may change wildly and you will need to have a clear designation in mind about who/what you're trying to protect at any moment. Failure to consider this step results in haphazard and ill-designed safety programs and poorly implemented countermeasures. Moreover, understanding what you're protecting helps focus time, resources, and attitudes more precisely.

Question 2. What are the risks to these assets?

In general terms, the primary risk for the gymnast is an unexpected fall to a non-forgiving surface, in a precarious posture, and from a height, swing, or run that is sufficient to result in high forces that lead to injury. The items listed above can occur singly or in combination with each item interacting with all the others. Teasing apart the interactions to focus more precisely on the actual risks or threats can be difficult. Moreover, there are other risks. One of the risks of gymnastics training is learning bad skill habits that intrude and interfere with later skill learning. Gymnastics injuries are not always acute; some injuries manifest themselves only after weeks or months of training and are called "overuse" injuries (Aldridge, 1987; Caine et al., 1997; Chan, Aldridge, Maffulli, & Davies, 1991; De Smet, Claessens, Lefevre, & Beunen, 1994; Steele & White, 1986). Coaches know that there are specific risks involved with each skill, and they establish and implement countermeasures to avoid and/or reduce these risks.

"The first rule of preventing and coping with accidents is understanding the risks you face. This is a multipart requirement and involves grasping the statistical risks – what's likely to happen each time you are exposed to the hazard, as well as the cumulative risk that arises over multiple exposures. Just as important, you must come to emotional terms with the fundamental difference between the probability of a mishap and the consequences should an adverse event come to pass" (Gerstein, 2008), p 241. Risks can be acute, cumulative, probable, improbable, foreseen, unforeseen, and so forth.

Risks do not have to be physical. Psychological stress and accumulated stress can also harm the gymnast. Much like post traumatic stress disorder (PTSD) the perceptions of a gymnast's abilities and his/her reactions to an injury can be as or more devastating to the gymnast as a physical injury. The combination of a high pressure competitive atmosphere, an inherently dangerous sport with regard to falling, and the fragile nature of young peoples' views of themselves and of others can conspire to destroy a promising career simply because the gymnast cannot cope (Chase, Magyar, & Drake, 2005; Feigley, 1987; Feigley, 1989; Gould, Petlichkoff, Prentice, & Tedeschi, 2000; Henschen, 1985; Kolt, Hume, Smith, & Williams, 2004; Kolt & Kirkby, 1994; Lindner, Caine, & Johns, 1991; Rotella, Ogilvie, & Perrin, 1993; Sachs, Sitler, & Schwille, 1993; Sanders, 1990). An "injury prone" personality has yet to be determined, but the coach needs to perform moment-to-moment assessments of the moods, focus, attitudes, and alertness of each athlete as he/she practices and performs (Ford, Eklund, & Gordon, 2000; Kolt & Kirkby, 1996; Leddy, Lambert, & Ogles, 1994; Sands, 1990b; Sands et al., 1991; Sands & McNeal, 1997; Shiraishi, 1999)

Finally, there are threats to the gymnast that come from sources outside of gymnastics. These hazards can be "trash talk" from other athletes, inappropriate expectations, pressures from the media, and overzealous parental involvement, among others (Bungum et al., 2000; Duda & Hom, 1993; Ryan, 1994; Weiss & Ebbeck, 1996; Weiss & Hayashi, 1995).

The risks of gymnastics skills are often obvious, but there are certainly historical incidences where gymnasts were harmed by slipping sideways from the

apparatus to land in an unmatted area, an off-hand comment that ruins an athlete's psychological preparation, apparatuses that were not set properly – even at an Olympic Games (Swift, 2000), and many others. The problem of determining skill readiness for a gymnast's first attempt at a new skill has been discussed previously and involves a gauntlet of questions that each coaching decision must pass through before allowing the gymnast to try the new skill (Sands, 1990a).

Question 3. How well does the safety solution mitigate the risks?

There are several general means of reducing risk in gymnastics. The various methods fall into several categories:

1. Safety in layers. Safety in depth means that there are multiple countermeasures that the gymnast must pass through before he/she is irretrievable from an injury circumstance. For example, a gymnast must be highly conditioned for the skill in question (first layer), the gymnast may be hand spotted by a skillful coach (second layer), and the skill may be performed over or into a foam pit (third layer). In assessing the three layers of protection listed above you should determine the weakest link because a safety failure is most likely to occur there. If the gymnast is not fit enough (strong, flexible, fast, non-fatigued, lean, and alert) then the conditioning item could be the source of an injury. If the hand spot is missed, or there is a miscommunication between athlete and spotter such that the spotter interferes with the gymnast and the gymnast and/or the spotter are injured then the spotting layer is likely a source of elevated risk. If the pit is incompletely filled with foam and in an un-fluffed condition. If the pit fails too then the gymnast's likelihood of injury becomes almost a certainty. Safety in layers is extremely important in preventing and reducing the magnitude of an injury. The more layers of protection used the less likely the gymnast will experience failure in all of the various countermeasures. James Reason illustrates this idea in his "Swiss Cheese" model. The basic idea is that each slice of cheese is a countermeasure. The hole(s) in the cheese slices represent failure of the particular countermeasure. In order, for a complete failure to occur the "holes" of the Swiss cheese must line up. As long as all the slices fail to line up as a single hole completely through all, then the injury is prevented and a countermeasure worked to prevent a problem (Gerstein, 2008), p 128.

2. Social Redundancy. Risks can be mitigated by something called "social redundancy," which can be thought of in two ways: multiple people are responsible for a decision, or you use people as direct countermeasures (e.g., multiple spotters to catch the gymnast). Social redundancy, as used with multiple spotters, proceeds from the hope that if the gymnast does something unexpected that at least one of the spotters will be able to prevent an injurious fall. Whenever a gymnast is going to attempt something for the first time, or when a gymnast may not be up to the task, the decision to continue should be spread across more than one person. This kind of social redundancy helps the coach and athlete increase their certainty about the skill in question. Coaches should work as teams in assessing a gymnast's readiness for any particular skill, routine, conditioning exercise, and so forth. The athletes themselves can also provide a part of social redundancy by indicating whether they think they're ready for a new skill or whether they think their teammate is ready. Gymnasts are often excellent sources of information and too often encouraged to remain uninvolved.

3. Avoid Denial. One of the most important means of implementing a safety culture and program is to avoid denial. Denial is a state of ignoring risks that are clearly present and possible while hiding behind the idea that nothing serious has ever happened before so therefore no one can

possibly be seriously injured. The absence of proof is not proof of absence. You don't want to make safety decisions based on an absence of evidence. Safety programs require vigilant observation of people, equipment, facility, conditioning, athlete status, and coaching practices. It is very important that you pay attention to weak signals and early warnings that an injury may be lurking (Sands, 1984). Moreover, don't wait until you have absolute proof of a safety threat before acting to impose logical and effective countermeasures (Gerstein, 2008).

Determining the risks actually faced by your asset(s) can be tricky and may rely on best guesses and abundant past experience. These are all acceptable as long as they result in a safer environment. One must be careful to avoid something called "safety theatre" in which safety measures are implemented but don't actually increase safety. In gymnastics one of the most overrated safety procedures is hand spotting (Sands, 1996). Human spotters do quite well when the falls are planned and the spotting and gymnastics skills are sort of a pre-rehearsed choreography. Catching an unplanned fall is a completely different story. Human beings are constrained by reaction times, information processing times, response times, and movement times. The segmented times listed in the previous sentence often conspire by accumulation to keep a skilled coach from catching the falling gymnast in spite of his/her best intentions (Sands, 1990a; Woodson, Tillman, & Tillman, 1992).

Question 4. What other risks does the safety solution cause?

"Unanticipated consequences," "collateral damage" and "revenge effects" have entered the modern lexicon referring to those things that happen as a consequence of some changes to a system that results in some things that were not predicted and largely unknown to the system designer. Revenge effects usually refer to the unanticipated results of unruly technology, so we will use "unanticipated consequences" (UC) for our purposes (Tenner, 1996). There are always UCs when something is changed in a dynamic system. For example, it is a common practice to place a large stack of skill cushions on the landing side of the vault table in order to practice various aspects of the vault with reduced fear and consequences of uncontrolled landings on a lower surface. The UC in this case is that the number of these types of mats in a gym is usually limited and by placing a large number of these mats behind the vault table, the other events may have to go without resulting in greater risk exposure at the other events or activities.

Following the introduction of foam pits to gymnastics, they were considered extraordinarily effective learning tools (Malmberg, 1978) and people were filling these large holes with many different types of loose foam pieces. There were many UCs that arose from these new loose foam pits. For example, in spite of the inherent softness of these pits, people could still get injured in them and athletes had to practice landing in the pits safely. Falls onto the head were not as safe as one might at first expect. Moreover, if an athlete is injured in a pit, one quickly finds that removing the gymnast from the pit presents some extreme obstacles to keeping the gymnast immobile while rescuers attempt to reach the injured gymnast (Finkel, 2001; United States Olympic Committee, 1995).

Everyone in gymnastics should consider what consequences are likely to follow all actions undertaken. Anticipating consequences of actions is one of the major hallmarks of an experienced coach. Often, the experts in any activity seem to almost magically anticipate problems before they become unsolvable and thereby protect the athlete while ensuring progress. Although safety is the current topic, a strongly related aspect of coaching is the selection and order of the content of skill progressions. Most

experienced coaches and teachers know that some skills have to be learned prior to other skills, and that some skills interfere with the learning of some future skills (Del Rey, 1989; Hickson, 1980; Lee, Swanson, & Hall, 1991; Magill & Hall, 1990). Experience in this realm is truly priceless and often nearly invisible to an observer.

Question 5. What costs and trade-offs does the safety solution impose?

Safety solutions are often expensive simply because they require more of something. In gymnastics, the most common safety equipment is found in soft matting. Mats tend to be expensive and have limited life spans. However, an appropriate mat can make all the difference in reducing risk to manageable proportions. Second to mats are foam pits, either solid or filled with foam blocks of various sizes. Foam pits can be built in the ground or above ground and can cost thousands of dollars. After mats and pits the costs of safety equipment can be seen in conditioning equipment, modern apparatuses, traffic control items, barriers that separate people such that collisions are avoided, and many others. Often trade-offs are made between new equipment, particularly mats, and old equipment that no longer meets the deceleration requirements needed to safely stop or catch a falling gymnast.

Trade-offs may sound somewhat confusing, but there are always trade-offs in gymnastics training safety. The very nature of the sport requires that the gymnast push his/her performance envelope ever higher by virtue of skill difficulty. Gymnasts may begin learning with multiple layers of protection (i.e., safety in layers), but ultimately the gymnast seeks to perform the skill with only a mat as the single countermeasure to prevent injury.

Trade-offs are often seen in the struggle between impatience and solid skill performance. While everyone would like to learn fast, there can be problems with learning too fast and thereby missing some of the important skills and means of escaping a mistake that naturally occur when progressions are long and painstaking. Dividing the skill into easier to learn smaller parts usually results in greater technical mastery, but the trade-off is time. The part-whole method of teaching/learning has been around probably as long as there have been skills to teach. Foam pits provide a good example of a potential trade-off by allowing gymnasts to do many repetitions with less fear of falling, but the foam pit doesn't ensure that the skills that lead to the target skill are well learned.

A serious trade-off seen in gymnastics training is the trade-off between difficulty of a skill and consistency of the skill. Usually the more difficult skill is less consistent than an easier skill. However, the Code of Points often forces the coach and gymnast into a precarious position of encouraging greater difficulty at the expense of consistency and safety (International Gymnastics Federation, 2000; Sands, 2000a).

CONCLUSION

In order to think sensibly about injury prevention and safety, you need to consider what you're trying to protect, what risks are the most prevalent, which countermeasures are most effective, the unintended consequences of the countermeasures, and finally the trade-offs that go hand-in-hand with implementation of a safety program and culture. Daniel Bernoulli once wrote that "fear of harm ought to be proportional not merely to the gravity of the harm, but also the probability of the event." This statement nicely summarizes a sensible safety program and culture. You must strike a balance between invoking countermeasures against the most egregious injuries and injuries that have the greatest likelihood of happening. In making these kinds of decisions it may be helpful to look to Aristotle who set out the patterns of inference (e.g., reasoning): deduction and

induction. However, he also described a third type of inference called apagoge. This third method of inference has also been called abduction or retroduction. The idea goes something like this: Some surprising thing happens or is observed. The thing that happens is explicable as a matter of course if something else were true. Hence, there is reason to believe that the something else is true. Turning the idea around, if you consider apparent risks and perhaps some trivial or rare risks as being potential threats to the safety of the gymnast, then you are obliged to invoke countermeasures against these "something else" threats. In a sense, it is using a hunch, a rule of thumb, and perhaps intuition guided by reason. Err on the side of being too protective, of invoking multiple countermeasures, of recognizing weak signals or small threats as potentially cumulative to become big threats, and do not be fooled by denial.

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