CHAPTER 13: MISCELLANEOUS SUBJECTS

MEDICAL RESPONSE TO INDUSTRIAL ACCIDENTS

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Industrial accidents vary in magnitude and affect groups of people differently. If only one worker is involved, it is traumatic to himself if to no one else. It may be a disaster to the plant depending on the amount of damage and how much the victims are indispensable. On a larger scale, the individual may be just a statistic or the only person in the country with a vital background. The only assumption that we will make today is that it is in the interest of everyone that the accident victim(s), no matter who, is salvaged in the best physical condition and returned to the work force as soon as possible.

PREINCIDENT

For good medical response that is effective many things must be accomplished before the incident occurs. First, there must be some sort of EMS (emergency medical service) in place There must also be medical support (hospital or on-site medical staff) available. This forms the basic need that must be met before we even start to think of helping an injured person. A basic rule is that the treatment given to an injured person prior to receiving definitive care will make the difference between returning the victim to the work force as rapidly as possible and the potential survival of the individual.

THE IDEAL SYSTEM

Before any thought of a plant is entertained there should be a good prehospital care system in place along with the availability of good, definitive medical care.

The first rung on the ladder is the first responder - the person who gets to the injured person first. It can be anyone, a fellow worker, security personnel, police etc. This person should have some first aid training, at least enough so that any life threatening occurrence can be immediately treated. This calls for a basic knowledge of CPR, bleeding control and basic shock management. This person's duty is to stabilize the victim until the arrival of a Basic Life Support (BLS) transport unit. Arrival time should be within ten minutes of the time of injury.

The BLS unit should be manned by at least two people with current training in all aspects of basic life support (CPR, oxygen therapy, shock control, splinting, bleeding control, patient assessment, basic HAZMAT control, etc.) The BLS unit should have all of the necessary equipment to accomplish their mission. If more aggressive therapy, is required, an Advanced Life Support (ALS) unit should be available and on the scene within the same ten minutes.

The ALS unit is basically an extension of the hospital emergency room and almost all emergency procedures that can be done in the hospital in the line of emergency first line drug administration, chest decompression, advanced shock control, etc. will be its stock-in-trade. Again, all training for the ALS personnel must be current.

The hospital emergency room should be within thirty minutes time of the injury site and be staffed with an emergency physician at all times. This physician should be trained in emergency medicine. Specialized emergency units should be within a transport time of an additional 30 minutes. Total time from the injury until the patient is in a specialized care facility should be less than 60 minutes. A severely injured multiple trauma victim who exceeds the "Golden Hour" in receiving specialized care has a very poor prognosis.

TRAINING TO MEET THE IDEAL

The First Responder will need training and it must be "refreshed" periodically, generally on a yearly basis. The amount of time needed would amount to about 8 to 16 hours. The number needed at any one site will depend on the type of industry and the hazards involved. In a construction industry the needs will be for more trained first responders than for clerical or food service industries. Data is readily available on the injury rates and severity for almost all types of industries. As the degree of injuries increase, the training level of the first responders should also increase. When the work group gets large enough they should have their own BLS unit.

In the case of a new plant being designed, the number of expected employees can easily be determined for the site. Also, the type of work and the expected injury and severity rates can be estimated. As the plant is being built and prepared for operation, specialized training can occur concurrently. In the case of a chemical plant, the raw materials, chemical intermediates, and finished products will be known, so training in safe handling and safety precautions can be started early. If qualified training experts are not available in house during the planning stages, they will have to be obtained from outside sources. This point is the most important, because if the initial planning is flawed, the entire project will have higher costs in terms of human life. Not only is the initial planning important, but the follow through is equally important.

It is realized that no one has an ideal system at this time, although some industrial areas approach it.

The following thought should be kept in mind. Only a limited number of people will pitch in and help in a large scale disaster, such as in Armenia, so they can quickly become overwhelmed and numbed by the immensity of the event. The same thing can happen to your EMS group and the back-up medical staff. A doctor in the emergency room who can function well for five or ten badly injured patients received in a short period of time will be ineffective if he encounters hundreds or thousands of patients.

It can be argued with good reason that it is the responsibility of the plant management to make available training in first aid and safe handling of equipment. The supply of specialty equipment, because of non-normal conditions or materials at the plant site, might even be required by local law. The reverse of this statement is even more true. It is the responsibility of the employees to take the training whether they are reimbursed for it or not. This is one of the few situations in life where we have a win/win situation. People who take the training tend to have fewer accidents and cause fewer accidents than those who are not trained. Often, because of the training, these individuals can foresee an incident before it develops and prevent its occurrence. At the least, a trained individual can minimize the effects of any incident.

THE SIMPLE INJURY

Let us now look at a simple trauma case, which will also be a baseline from which we can scale up. We will look at a single soft tissue injury and follow what happens to an injured person.

The largest number of injuries that occur in the work place consist of limb trauma, ie. sprains, strains, and breaks of the extremities. No one is immune to this type of trauma, but there are ways to minimize the effects.

What we do immediately after an accident has occurred will largely determine what the cost in time, money and pain will be. Quick and proper intervention will minimize the costs.

First, let us look at the effects of trauma and then we will see what we can do to minimize these effects Trauma must first be split into two categories, primary or initial trauma and secondary trauma. Primary trauma is that caused in the first instant of injury. All trauma is caused by the application of some sort of force to tissue. The force can be of either internal or external origin. The severity of the primary injury will be set by the amount, duration, and placement of the force applied. No matter how small the amount of force or how slight the injury, there will be cell damage, capillary rupture, and histamine release. The extravasation of fluid causes secondary damage. If the patient is not treated properly, secondary damage might continue to occur and spread the area of injury for up to 72 hours.

It is in the area of secondary trauma where we can make a strong contribution to the well-being of our workers. Soft tissue damage means damage to the vascular bed and to individual cells. The more severe the injury, the larger the area of damage. This damage takes several forms. First, there is leakage from the capillary bed into the interstitial areas in the tissue. This leakage is part of the cause of the swelling that occurs at the injury site. There is also a shift of fluids from the lymphatic system into the injured area to help fight any foreign bodies that are at the wound site. The body treats blood cells located out of the vasculature as it treats any other foreign body. The damaged cells also start to release histamine for defending the body and cleaning up the area. The histamine release increases the permeability of the cells and the vasculature which in turn brings more fluid into the area. Because the skin is only partially elastic, the swelling becomes partially splinted. If the injury is in the area of a joint, histamine also helps to remove the damaged collagen from the injury site, however histamine also removes some of the non-damaged collagen. Collagen that is initially produced by the body tends to be laid in a linear pattern with a smooth and slippery surface. Repair collagen, however, is laid down in a random fashion with a surface that is not smooth or slippery. This reaction leads to a limited range of motion and its associated pain.

Any injury will go through the previous stages, regardless if it is a simple sprain or a total crush injury, however the size of injury and the number of people afflicted can vary in degrees.

REALISTIC CONDITIONS

As was said earlier, no one has the ideal medical response system for industrial accidents. All are alleged to be seeking it and some are closer to it than others, but none have it. Like any long sought ideal, the closer you get the harder it is to make a difference. If you are in the condition described earlier, any positive change will lead to greatly reduced mortality and morbidity rates. If you have a good experienced system at your disposal, you may have reached the state where you are trying to shave seconds off your response time.

If you only need to reduce the response time by a few minutes, you are well aware that for minute improvements, the cost is huge. If you decide not to further improve the system, you have decided how much you can afford to save life. It is an unfortunate fact of life, that the monetary resources needed to do everything the way it should be done are always less than the total available. If you try to have the incoming industry carry too much of the financial load of your infrastructure, they will go elsewhere. This means the jobs that were to employ your people will not be there. Your population must become more aware of what is going on about them and they must accept some of the responsibility. Local citizens and their government must not allow risky ventures such as the construction of a chemical plat in a yearly flood plain, the building of an explosives factory in the middle of town, or designing a manufacturing plant with no safety factors.

Now that we have looked at the ideal and problems of trauma patients, let us look at the effects of large scale incidents that go beyond the plant gates and affect the population at large. This will be broken into two parts, the first part involves determining where we find experts,

and the second part describes the medical response needed to reverse the effects of a disaster.

IN-HOUSE EXPERTISE AND INFORMATION SHARING

Long before the plant is in operation, the management of the plant and the local emergency response group should have planned together for the maximum credible accident. Whenever there is a change in the hazardous materials kept at the site or a change in the way materials are processed, the group should meet and bring the plan up to date. The only way a local official can meet a disaster situation involving a plant is to know what is in the plant and what has been released. If you are dealing with a nuclear power plant or a concrete plant the answers should be simple and straightforward. A chemical plant, however may be making a hundred different substances. That is why you must know about the materials and processes involved for each plant in your region.

Contingent to receiving an operating permit, part of the safety review should contain a description of the processes done at the plant, the types of chemicals used, the amount of each chemical, and the medical protocol in the event of an accident. It would also be prudent to plan for the supplies needed for the worst case scenario. For example, if the problem is a possible organophosphate release there should be enough atropine available to treat the population in the area. In any case, all first responders and EMS personnel should be knowledgeable of the effects of poisoning by the local materials. As the local general educational level declines the people that will be first on the scene need a greater working knowledge.

Planning on the part of the civil establishment must include drills which involve not only the responding organizations but plant expertise. These drills should start out as paper drills including what is at hand in the way of personnel and equipment and then be examined in light of effectiveness. This should then be followed by drills where a scenario is acted out and the response by local groups is watched to uncover weaknesses in the plan. The most common problem in almost all drills is in communication between the people who know what to do and the people actually doing the work.

Plant personnel can help teach industrial safety and assist outside responders. This information is of the highest priority, because it will reduce the number of lives lost to industial accidents.

While we are talking primarily about industrial plants, it is important not to forget about local government plants, such as the local water works. In many countries, the local water supply is treated with elemental chlorine. If the chlorine tank should leak, you will need protective clothing and self-contained breathing equipment for the people who are working to contain the spill. The same would be true for those making fertilizer using liquid ammonia in the process.

Every product that is in your area must be examined for its hazard potential. In many areas of the world today ammonium nitrate is used as a fertilizer and it is not uncommon to find tons of it in storage in an agricultural community. Normally it is a very safe material. However, in accidents such as in Texas City, USA, many of the initial responders were killed and their equipment destroyed when the material blew up.

Many villages that are dependent on kerosene or gasoline lamps for light are at extremely high risk of fire due to even small amounts of the combustible liquids.

The sooner you know what you are confronting in an accident, the more lives you will save.

INDUSTRY PARTICIPATION

Most industries consider programs that improve local emergency response to be good business practice. They actively pursue opportunities for their people to talk with local response personnel. They explain the best way to handle the hazards involved in their business, they give tours of plant sites to local response units, and generally make their internal response units available to the community. By doing this they get the local communities "on their side" should a real problem arise. For example, an electric power plant in my community keeps enough basic EMS supplies on site to care for over 1000 trauma casualties even though their on-site staff is less than 100 at any time. Additionally, a medical supplier keeps a supply of bandage materials available in one of the warehouses for a possible disaster. All that is needed to get these supplies is a request from the local disaster coordinator.

PROBLEMS IN INDUSTRY PARTICIPATION

Industry as a whole is ambivalent about incident preparation. They do not want to see a plant out of production or damaged; that costs money. Conversely, it is often felt that if all of the dangers associated with any plant become too widely known, then the local people either might not work there or will not allow the plant to operate.

One obvious conclusion that can be drawn from this paper is that if funding is small, the most effective use of the bulk of funding will be in training the population at large to be first responders. Even if you have the most advanced hospital health care system, if you cannot get the patient to the medical care facility in salvageable condition, you have wasted your funding and raised false hopes in your community.

Two last thoughts, although I do not normally recommend spending money that cannot demonstrate a direct relation to improving the bottom line, this field is one in which the view of an outside consultant can be extremely useful. As long as the outside person is

unbiased, he can often see what has been overlooked. I have seen too many projects run into manifold problems because the people who review the proposals have been too close to the situation.

A final thought comes from listening to various discussions at this conference. I have become concerned with what seems to be a distortion of priorities. While it is nice to have a modern trauma unit, it is almost a total waste of funds if it takes many hours or days to get trauma victims to the unit. When this occurs it is analogous to building the top of a pyramid before the base. The effect on overall morbidity and mortality would be much greater if the same funds were used to provide first responders and basic life support units. Reduction of delay in initial treatment should be the primary goal of everyone. Once the time to initial treatment has been reduced to an acceptable level, then and only then is when we should worry about the provision of higher level intensive care facilities.

INJURY DEATHS AND AMERICAN TRAVELERS

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INTRODUCTION

An estimated 30 million United States citizens travel overseas every year.[1,23] Improved air travel, decreasing costs, and continuing curiosity suggest that international travel will be the world's number one industry in the twenty-first century.[2,23] In addition, tourism represents an important source of hard currency to many countries, particularly less-developed countries.

Every year, though, thousands of tourists become ill or injured during their travel. The morbidity related to travel from illness has been described in the literature.[2-14] However, travel-related mortality of US citizens has not been described. Hargarten and Baker looked at Peace Corps fatalities,[15] and noted that injuries are the leading cause of death.

This study is part of a larger inquiry into the causes of death of US citizens residing and traveling outside the US[16] Injuries have been noted to be a leading cause of death of travelers. This paper describes in further detail the mortality experience of US citizens who travel and whose cause of death was an injury event.

METHODS

These deaths are not recorded or analyzed by the National Center of Health Statistics.[17] The consuls are notified by the local authorities in the event of a death of an individual who carries a US passport. The death certificates are sent to the US Passport Office by the Consular Representatives of the US or their designated representatives in the various countries of the world.

We examined two years of data from deaths of Americans overseas in the passport section of the Department of State. We selected the oldest year that was readily available, 1975, and the most current year that was complete, 1984. We analyzed all deaths under age 60 and randomly sampled 20% of the deaths in ages over 60.

Data on the American tourist population was taken from the World Tourism Organization (WTO).[18] Conversion to an annual exposure was accomplished by calculating the "nights in hotels and other lodgings" for countries reporting to the WTO, extrapolating this number to all countries, and dividing for "estimated nights stayed" per traveler by 365 days. This was then multiplied by the number of travelers to determine person years of exposure.

Data obtained from death certificates included cause of death, country of death, age at death, sex, whether medically certified or not, location of death (hospital or home), whether resident or traveler, and occupation. This data was transcribed and tabulated. Names and original residences in the US were eliminated to preserve confidentiality.

The ninth edition of the International Causes of Disease (ICD Reference) was our basis for coding the deaths. To obtain an adequate number for analysis, we combined the codes to: cardiovascular, neoplastic, injuries (by type), other medical diagnosis, and difficult to define causes.[19] The quality of reporting varied considerably, however the majority of reports were sufficiently accurate to permit coding.

Data from the World Bank was used for comparison of developed and developing countries.[20] Per capita GNP of less than US $2,000 and male life expectancy in 1983 of less than 65 years were used to divide developed and undeveloped countries. Male life expectancy was used, as there were more males than females in the sample of deaths studied.

RESULTS

There were 601 travel deaths of US citizens during the study years of 1975 and 1984. There were 279 deaths in 1975 and 302 deaths in 1984. Results of the two years were combined and 20% of the deaths were under age 25.

The major causes of injury deaths were motor vehicle crashes (Table 1), followed by drownings, homicides and plane crashes. Travelers who died of unintentional injuries expired outside hospital settings 81% of the time. Motor vehicle crash deaths occurred outside the hospital 73% of the time, and 91% of drowning deaths occurred outside the hospital. There were 72 homicides and suicides during the study period. Eighty-two percent were male, 11% occurred to travelers under age 25.

Fifty-nine percent of the deaths occurred in less developed countries. Mexico alone accounted for 32% of injury deaths, 42% of homicides, and 38% of drownings.

Injury death rates for US male travelers were consistently higher when compared to US residents in all age groups. The injury death rates for US male travelers were consistently higher in less developed countries than in developed countries. (Mexico was excluded from these rate analyses due to poor denominator data).

DISCUSSION

Our study looked at injury deaths of US, citizens which occurred outside the continental US, excluding Canada. Serious injuries which occurred to travelers resulting in deaths within the US are not included in this analysis. Data suggest that injuries are the leading cause of medi-vacs of US citizens back to the US[22]

Possible explanations for the increased risk of injury deaths of US male citizens while traveling include more risk-taking behavior in this travel group, unfamiliar roadways and swimming areas, and increased environmental hazards in countries such as poorly designed roadways and inadequate barriers. An additional environmental factor is the lack of developed emergency services. Emergency medical services are rudimentary in some countries and totally absent in others.

Due to limitations of our data source, we were unable to determine blood alcohol levels in tourist deaths, or usage of safety devices such as seat belts and helmets.

Injury prevention strategies should consider host traveler and environmental factors.

Host strategies (Table 2) should stress avoidance behaviors as well as constructive behaviors. Physicians advising US travelers to other countries should stress these strategies along with the strategies for avoiding malaria and traveler's diarrhea.

Environmental strategies should include the broadening of governmental regulations, the improvement of roadway design, and the development of emergency medical services. Examples of government regulations would include requiring rental agencies to provide seat belts and helmets with the car and motorcycles they rent to tourists. Improved roadway designs can decrease crashes by removing objects near roadways. In addition, barriers can be placed in certain areas of the roadways which are energy-absorbing. Emphasis on roadway design has led to improvements in highway safety in the US

The development of emergency medical services would provide prompt and safe transport and treatment for the injured traveler leading to reduced morbidity and mortality.[21]

Further studies describing the frequency and distribution of non-fatal travel related injuries are needed. As mentioned, the role of alcohol was not included in this analysis and needs to be explored in future studies.

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TABLE 1

Injury Deaths of US Citizens - 1975, 1984
Travel Outside the Continental USA

Cause of Death	No. of Deaths 1975, 1984	Percent of Total
Motor vehicle crash	163	27.1
Drowning	96	16.0
Plane crash	43	7.2
Homicide	52	8.7
Poisoning	9	6.5
Suicide	20	3.3
Burns	21	3.5
Electrocution	3	0.5
Others	164	27.2
TOTALS	601	100.00

TABLE 2

Injury Control Strategies for US Tourists

1. Avoid motorcycles and small, less protective vehicles, or at least helmets when using these vehicles;
2. Avoid traveling at night;
3. Avoid using small, non-scheduled aircraft;
4. Use seat belts where available, including taxicabs;
5. Use larger vehicles and avoid riding in the back of open trucks;
6. Carefully select swimming areas and avoid consuming alcohol while swimming;
7. Travel in groups or pairs.