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A Study of Fatal Trauma

Earl B. Sanborn, M.D.*

SUMMARY: Treatment of the complications of the injured patient is frequently more important than the injury itself. Such complications as shock, traumatic wet lung, atelectases, etc., are a direct result of the injury. Patients may suffer obvious severe trauma, only to die of the unrecognized and untreated complication. Post-mortem examinations establish the nature, extent and effect of trauma—i.e., causation, from the lawyer's as well as the physician's point of view.

In all cases of death following traumatic accident, the lawyer should investigate the un-apparent as well as the obvious injuries; ordinarily by use of autopsy. In a surprising number of cases inadequate medical treatment is found to be a contributing cause, or the proximate cause, of the death.

PATIENTS WHO SURVIVE TRAUMA and are able to be transported to the emergency rooms of hospitals for treatment are the responsibility of the medical profession. Some of these patients succumb although they apparently have good care.

For several reasons, I conducted an investigation of such a fatal group. I wished to stimulate members of the professions involved to attend such patients with greater interest. I also hoped for improvement of the management of all patients sustaining trauma and that a base line would be established which could be used for comparison with future investigations. Such a study might aid civil defense and other agencies.

I chose two suburban hospitals for the investigation. Suburbs have increased in number and size since World War II, and are thus comparable to many of the smaller cities throughout the country. Their problems in regard to trauma are typical of those in smaller cities throughout the country.

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[*Editor's Note:* This is an expansion of a paper recently delivered at an Annual Meeting of New York Orthopedic Hospital Alumni Association. Some of this material appeared in the American Journal of Surgery, Volume 94, Number 3, pages 378-386. The expanded material, here presented, is a complete rephrasing written for lawyers.]

Clinical Material and Results

Through the kindness and assistance of the personnel of the record rooms of two hospitals in different suburbs of the metropolitan area of Chicago, I was enabled to examine over 100 clinical records of patients who died of trauma thirty minutes or more after hospitalization. One of the hospitals, Hospital A, is located in Cook County. The other hospital, Hospital B, is situated in Lake County. Table I includes the type and number of each accident in this series. The fatalities occurred at Hospital B between February 18, 1950 and January 2, 1955, and at Hospital A between January 18, 1951 and December 21, 1952.

TABLE I

<u>Type of Accident</u>	<u>Hospital A</u>	<u>Hospital B</u>	<u>Total</u>
Automobile	28	7	35
Fall at home	19	5	24
Pedestrian:			
Struck by auto	11	1	12
Struck by train or street car	2	1	3
Burned (at home)	6	1	7
Fall at work	3	2	5
Fall due to bad weather (ice, etc.)	3	1	4
Penetrating bullet wounds	3	-	3
Suicidal attempt	2	2	4
Assault	2	-	2
Motorcycle	1	-	1
	<u>80</u>	<u>20</u>	<u>100</u>

Over 50% of the patients in this series were over 60 years of age. Except for the patients in their seventies, of whom there were twenty-three, there was an almost uniform distribution of ten patients in each decade, from the twenties through the eighties. In this study, there were very few young females, who, apparently, are better able to avoid fatal trauma. This is not true of older members of this sex, for they frequently fall and sustain fractures of the hip.

TABLE II

<u>Significant Injury</u>	<u>Hospital A</u>	<u>Hospital B</u>	<u>Total</u>
Cranio-cerebral injury	35	3	38
Fracture upper extremity of femur	16	3	19
Rib fractures and associated trauma	10	7	17
Severe thermal burns (60-85%)	6	2	8
Penetrating wounds of abdomen	3	-	3
Multiple fractures	2	1	3
Penetrating laceration of neck	1	-	1
Multiple fractures of pelvis	1	-	1
Tension pneumothorax	1	1	2
Fractures of vertebrae:			
cervical	1	-	1
lumbar (first)	-	1	1
Multiple lacerations (suicide)	1	-	1
Fracture of clavicle, right	1	-	1
Fracture of humerus, left	1	-	1
Contusion of hip, right	1	-	1
Contusion of elbow, right	-	1	1
Rupture of thoracic aorta	-	1	1
	<u>80</u>	<u>20</u>	<u>100</u>

Table II shows the classification of the significant injuries in this series. If a patient had two or more injuries, only the more serious one was listed. However, in Table III are included the multiple injuries sustained by the patients, as well as their incidence.

TABLE III

<u>Multiple Injuries</u>	<u>Hospital A</u>	<u>Hospital B</u>	<u>Total</u>
Cranio-cerebral and multiple fractures	10	1	11
Cranio-cerebral, thoracic injuries and fractures	9	5	14
Rib fractures and multiple fractures	3	-	3
Cranio-cerebral and multiple lacerations	4	-	4
Cranio-cerebral and fractures of vertebrae	2	-	2
Tension pneumothorax and cranio-cerebral	2	-	2
Penetrating laceration of neck and thorax	1	-	1
Penetrating wounds of skull and abdomen	1	-	1
Cranio-cerebral and dislocation of shoulder (L)	1	-	1
Rib fractures and hemopneumothorax	-	2	2
Tension hemopneumothorax and fractures	1	-	1
Rupture of aorta, hemopericardium, hemothorax and multiple fractures	-	1	1
Total	<u>34</u>	<u>9</u>	<u>43</u>

As is true in other fields of medicine and surgery, the fatalities in this series were frequently due to one or more complications or other clinical entities. For this reason, they are listed respectively in Tables IV and V.

TABLE IV

<u>Complications</u>	<u>Hospital A</u>	<u>Hospital B</u>	<u>Total</u>
Traumatic shock	34	11	46
Traumatic wet lung	27	7	34
Pneumonia (broncho or lobar)	17	3	20
Cardiac failure	9	-	9
Uremia	9	-	9
Pulmonary atelectasis	8	4	12
Cerebral edema	6	-	6
Acute toxemia (burn cases)	6	2	8
Upper respiratory tract obstruction	3	3	6
Decubitus ulcers	3	-	3
Delirium tremors	3	-	3
Cerebro-vascular accident	3	-	3
Pulmonary embolism	2	2	4
Crush Syndrome	2	-	2
Paralytic Ileus	1	2	3
Infarct of kidney	-	1	1
Embolism—peripheral vessel	-	1	1
Cardiac arrest	1	-	1
Coronary occlusion	1	-	1
Total	<u>136</u>	<u>36</u>	<u>172</u>

TABLE V

Clinical Conditions Affecting Deaths Due To Trauma

	<u>Hospital A</u>	<u>Hospital B</u>	<u>Total</u>
Senility or arteriosclerosis	26	5	31
Obesity	4	3	7
Pulmonary emphysema	-	2	2
Diabetes mellitus	2	-	2
Toxic nodular goiter	-	1	1
Bronchial asthma	1	1	2
Secondary anemia	1	1	2
Varicose veins	1	-	1
Total	<u>35</u>	<u>13</u>	<u>48</u>

It would be desirable to correlate the findings of the post-mortem examination with the clinical records. Unfortunately, there were very few autopsy protocols. Only seven of eighty patients in Hospital A (8.7%) had an autopsy report in the clinical record, whereas in Hospital B, nine of twenty patients (45%) had such an examination performed. Thus 16% of these 100 cases of fatal trauma had an autopsy.

A survey of ten additional records of patients who expired within forty-five minutes after admission to the emergency room of Hospital A revealed that the average age of the patients was 39.5 years. Other facts concerning this small series are given in Table VI. No autopsies were performed on any of these patients!

TABLE VI

Type of Accident	Age of pt.	Significant Injury	Time Elapsed After Admission
(1) Pedestrian (struck by auto)	4 yrs.	Cranio-cerebral	3 min.
(2) Pedestrian (struck by auto)	64 yrs.	Cranio-cerebral	5 min.
(3) Passenger of automobile	7 mos.	Cranio-cerebral	10 min.
(4) Was shot attempting "hold up"	18 yrs.	Penetrating wds/chest	25 min.
(5) Run over by a truck	49 yrs.	?Multiple fractures	32 min.
(6) Automobile accident	66 yrs.	Cranio-cerebral plus fractures	30 min.
(7) Automobile accident	27 yrs.	? "Broken neck"	30 min.
(8) Automobile accident	37 yrs.	?Cranio-cerebral	3 min.
(9) Truck accident at work	39 yrs.	Cranio-cerebral	44 min.
(10) Automobile accident	90 yrs.	Multiple—chest and head	5 min.
Average age	39.5 yrs.	Average time	18.7 min.

Chief Causes of Injury

This study confirms the acknowledged fact that motor vehicles are causing a disturbing number of deaths and serious injuries. In Table I, it can be seen that approximately 35% of the fatalities in this series were due to mobile vehicles; pedestrians were victims in over 15% of the remaining cases. Many fatal accidents have always occurred in the home. In this series, 31% were due to falls and burns sustained at home. Thus the automobile and the home are etiological factors in over 80% of the fatalities due to trauma.

This study indicates that in the future more attention should be focused on the treatment of trauma in the aged.

Cranio-cerebral Injuries

Approximately 40% of the fatalities involved injury of the brain or skull, or both (Table II). The average age at death was 44.7 years. George F. Strong,¹ past President of the Canadian Medical Association, in an address on traffic accidents, made a pertinent statement concerning *life years*. (*Lost life years* are calculated by subtracting the age at death from the expected age of death for the individual. For example, a man dies at 60 although he has a life expectancy of 70 years; his premature death has resulted in the loss of ten life years.) In 1952, in British Columbia, heart disease was the leading cause (36.2%) of all deaths, but it represented only 12% of the life years lost for all

¹ Strong, G. F.: *The Medical Profession and Traffic Accidents*, 158 J. A. M. A. 905 (July 16, 1955).

causes of death. Cancer, the second cause, accounted for 15.7% of all deaths, but cancer was responsible for only 10.0% of life years lost from all causes. Accidents, while ranking third in the cause of deaths (7.9%), were first (17.5%) in the number of life years lost. Less than one-third (29.0%) of the patients with cranio-cerebral injuries in the series herein were over sixty years of age.

A survey of these cranio-cerebral cases revealed that over half of them were in shock on arrival at the hospitals. Although the patients were immediately treated for shock, some never recovered. Undoubtedly more attention should be given to the management of shock and less to minor surgery in the emergency room.

A scrutiny of the records revealed that approximately one-half of these patients, according to their signs and symptoms, had the so-called traumatic wet lung syndrome.² Immediate tracheotomy is indicated, but these were not performed during the early hours of hospitalization. A few of the patients had additional injuries involving the nose and face, with bleeding into the upper respiratory tract. An attempt was usually made in these cases to clear the mouth and pharynx. However, all of the procedures utilized did not prevent a number of the cranio-cerebral group from developing pulmonary complications. Better management of the patient in shock with more attention to maintaining an adequate airway and a sufficient intake of oxygen should decrease the number of deaths due to all types of serious injuries and especially those of the cranio-cerebral group.

If more autopsies had been performed, a better understanding of the causes of death in the cranio-cerebral cases would have resulted. Certainly confirmation of the clinical diagnoses, such as cerebral edema, contusion of midbrain, and basal skull fracture could be made.

Hip Fractures

There were nineteen patients who had fractures of the upper extremity of the femur. All except one were elderly women (average age 82 years). Probably more of this group would have survived this type of injury had more attention been paid to the cardio-vascular and pulmonary systems. At least four of the group were said to have died of cardiac failure. Two had

² Sanborn, E. B.: Clinico-pathologic Aspects of Traumatic Wet Lung, 87 *Am. J. Surg.* 457-461 (March 1954).

cerebro-vascular accidents, and one probably died of cardiac arrest in the operating room. On the basis of personal experience, I recommend rapid digitalization of all patients of the elderly age group sustaining fractures of the femur. Very few patients in this series were digitalized, and then only after several days of hospitalization.

None of these patients were clinically in shock when first seen. The recorded blood pressure and pulse readings at the time of the initial examinations confirm this. Thus shock is not a good excuse for delayed operation in this group. Consultation with medical colleagues, rapid digitalization, and earlier surgery are advocated in the elderly patient sustaining a fracture of the hip.

Rib Fractures and Associated Trauma

Seventeen patients had fractures of one or more ribs. One of two additional patients with a unilateral tension pneumothorax did not have a rib fracture. Fourteen patients of this group had multiple (3 or more) fractures of the ribs. Cameron, O'Rourke and Burt³ have reported the importance of good management of these conditions. Another group has stressed the significance of the fractured rib.⁴

Unilateral tension pneumothorax was present in two patients. A 32-year-old male died eleven hours after admission; the diagnosis was made at the post-mortem examination when air escaped under pressure as the left pleural cavity was opened. During hospitalization this patient had stated that he could not breathe, but nothing was done to determine the cause of his dyspnea. The other male patient, who died less than five hours after admission, was 37 years old. In the first case a consultant recommended no interference. In the second a single aspiration of the involved pleural space was performed. Each of these young men might have been saved by the proper diagnosis and management.

The average age of the patients in this group was 55. Ten of the patients were in shock when first seen. At least half of the patients in the rib fracture series apparently had the traumatic wet lung syndrome. When first seen four of these were in shock.

³ Cameron, D. A., O'Rourke, P. V., and Burt, C. W.: An Analysis of the Management and Complications of Multiple (3 or more) Rib Fractures, 78 *Am. J. Surg.* 668 (November 1949).

⁴ Rapport, R. L., Allen, R. B., and Curry, G. J.: The Fractured Rib—A Significant Injury, 71 *A. M. A. Archives of Surgery*, 7 (July 1955).

This state is one of the etiological factors in the development of the traumatic wet lung.

Fifteen patients died in less than seventy-two hours; the average period of hospitalization was 23 hours. The seriousness of thoracic injuries in civilian life is emphasized by the short duration of life in some of these cases after injury. In addition to shock, fourteen had associated head injuries. Thus it is very important that patients with both types of injury be managed very carefully. The significance of adequate oxygenation of the lungs and brain in this group cannot be over-emphasized. Likewise the early use of tracheotomy in certain cases is recommended.

The older age group apparently does not tolerate trauma to the thorax very well. Nine patients were over sixty years of age. Prevention of cardiac complications needs to be stressed. Elderly patients with thoracic injuries should be mobilized in the hospital as soon as possible. They should not be confined to bed unless absolutely necessary.

Only five of the patients (approximately 30%) in this series had post-mortem examinations. The autopsy protocols in the clinical records were revealing, especially as to pathology of the tracheobronchial tree and the lungs. As was previously mentioned, a tension pneumothorax was found in one and a large clinically unrecognized pulmonary embolus in another. Two others demonstrated the pathology of the traumatic wet lung syndrome.

Burns

There were eight patients who died of severe thermal burns. The burns were calculated as covering 50% to 85% of the body surface. Two patients were four years of age or younger. Two were in the sixth decade and four were 65 years of age or older. Seven of the burns occurred in the home; one was the result of an automobile accident.

Six of those burned were in shock when first seen, and they did not recover from this state. Seven of the eight died within thirty hours after admission to the hospital. Their average period of hospitalization was thirteen hours. Although four of this small series received oxygen therapy (one by tent and three by nasal catheter), four apparently did not. There were respiratory tract complications in three patients. In two patients the nasal airway was blocked by dried blood, and in a third apparently a traumatic wet lung syndrome developed.

Thus one concludes that the severely burned patient is a therapeutic problem that has not been completely solved by modern surgery and medicine.

Multiple Injuries

The problems of multiple injuries are indeed present in suburban and smaller city hospitals. This is well demonstrated in Table III, where 43 cases are listed. It is significant that cranio-cerebral injuries were present in 81.4% of the patients, and thoracic injuries were associated with other types of trauma in 53.5%. Future management of trauma must continue to recognize the seriousness of these two categories of injuries. Seventy-six and seven-tenths per cent of the patients with multiple injuries had fractures or dislocations. (Rib fractures are excluded from this calculation.) Contrary to a popular opinion, the injured patient is best managed by a surgeon who is experienced and interested in trauma.

Complications

A number of the complications listed in Table IV have been referred to in the above discussion. Their prophylactic and therapeutic aspects have been mentioned. A list of the clinical conditions affecting the deaths in this series is given in Table V. Certain statistics are significant. Shock was present in almost half (46%) of the cases. *Pulmonary complications were greatest in number*, seventy-six to be exact, and included were traumatic wet lung, pneumonia, atelectasis, obstruction of the airway and embolism. Apparently more attention must be centered on prophylaxis of these. Cardio-vascular complications totaled sixteen. The surgeon must be cognizant of these also. Avoidance of pulmonary and cardiovascular complications naturally reduces the number of complications in other systems.

Post-Mortem Examinations

“Those who dissected or inspected many bodies
Have at least learned to doubt
When others, who are ignorant of anatomy
And do not take trouble to attend to it are
in no doubt at all.” . . . Morgagni.

Dr. Denny of India⁵ prefaced his interesting article on the causes of death due to trauma with the above quotation. As

⁵ Denny, D. J.: The Cause of Death in Traumatic Injury, 21 J. Indian M. A. 87 (December 1951).

Professor of Forensic Medicine, he knows the value of post-mortem examinations in fatal trauma as well as in other deaths.

The difference between the percentages of autopsies performed in cases of trauma in two well-known Illinois counties have been mentioned. In Lake County, the Coroner (Illinois law does not require him to have medical training) cooperated with the pathologist and other members of the medical staff in almost half (45%) of the cases of fatal trauma. In Cook County, the Coroner, who is also a layman, or his representative, failed to cooperate in having autopsies performed in most of the fatally injured. Frequently, approval for such an examination had been obtained from the family by the attending physician or surgeon, but the Coroner's office did not authorize the examination.

It is only through complete post-mortem examinations that the extent and effect of trauma can be seen. Certainly such examinations would result in better comprehension of the true cause of death by the pathologist, and attending physician, as well as the actual complications in the fatally injured. Future management of the injured would be improved as a result of this knowledge.

Fatal Trauma in the Emergency Room

Table VI, which includes facts concerning ten patients who died of trauma within forty-five minutes after arrival at the hospital, is included to focus more attention on the early management and transportation of the injured, as well as their immediate treatment in the Emergency Room. Most of these patients must have died of complications, namely, traumatic shock and obstruction of the respiratory tract, as well as their injuries.

Can anything be done to improve the mortality rate in this group of patients? Possibly the first aid which the patients received was not always the best. In the military services, trained enlisted men have been taught to give Dextran, or other reliable blood substitutes, in the cases of shock. Possibly police officers and other personnel connected with civilian ambulances also should be given this training. The importance of proper positioning of the patient and maintaining a clear airway, if possible, during transportation should be further emphasized.

Some of the suggestions made above concerning the treatment of shock and prevention of pulmonary complications should be *followed more closely in the emergency room*. If possible, upright portable thoracic roentgenograms should be taken in the

emergency room of patients with chest injuries, especially if dyspnea or cyanosis is present. Apparently tension pneumothorax should be suspected and treated more often. The same is true of hemothorax and pneumothorax, as well as the traumatic wet lung syndrome. As early as possible, a surgeon interested and trained in trauma of the thorax should see patients with these conditions. This is as important as early evaluation of the patient with cranio-cerebral injuries by a surgeon trained in their management.

The paucity of information concerning vital signs (blood pressure, pulse, respirations, and state of responsiveness) of the patients seen in the emergency room is significant. Every patient who was seen in this department had a single page form with pertinent data as to address, nearest relative, etc., but the space given to the diagnosis, treatment, etc., was limited. It would seem wise to have a form for recording regularly the vital signs from the time the patient arrives at the hospital. Such data, plus the significant observations, are of value in making decisions concerning major surgery and other forms of therapy. This new form should be made a part of the permanent clinical record.

Summary and Conclusions

1. A study of over 100 clinical records of patients sustaining fatal trauma has been made in the hope that results will be of value in assessing some of the present problems in the field of trauma.
2. The increasing importance of the role of trauma and its management in the elderly is stressed.
3. Observations and suggestions have been made concerning the treatment of significant and multiple injuries.
4. There is a need of proper laws governing post-mortem examinations in the fatally injured in some states.
5. Some recommendations are made concerning the early treatment of the injured.
6. The blood pressure, pulse, respirations, and state of responsiveness should be recorded, at regular intervals, in the emergency room in the cases of the severely injured, on a form which can become a part of the permanent clinical record of the patient.