

Papers and Originals

Agricultural Tractor Accidents

A Description of 14 Tractor Accidents and a Comparison with Road Traffic Accidents

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Every year approximately 50 people are killed and 1,000 injured in England and Wales through accidents to tractors. Apart from the mortality and morbidity figures published by the Ministry of Agriculture, Fisheries, and Food (1964), and shown in Table I, no objective data have yet been published on this subject.

TABLE I.—Fatal and Non-fatal Accidents and Diseases in Agriculture in England and Wales

	1959-60	1960-1	1961-2	1962-3	Total	
<i>Fatal Accidents and Diseases</i>						
Total	110	138	120	116	133	
Tractor accidents only	40	64	57	51		
Overturned	25	43	37	28		
Overturned from silage heaps	2	3	-	2		
Falls from	11	8	9	15		
Various	2	10	11	6		
% of all fatal accidents due to tractors	36.3	46.4	47.5	44		
% of fatal accidents due to tractors overturning	22.7	31.1	30.8	24.1		
<i>Non-fatal Accidents and Diseases</i>						
Total	12,233	10,871	11,236	12,777		310
Tractor accidents only	1,050	971	1,046	1,107		
Overturned	78	53	81	98		
Overturned from silage heaps	3	1	1	4		
Falls from	269	239	259	259		
Other causes	700	678	705	746		
% of non-fatal accidents	8.6	8.9	9.3	8.7		
% of all non-fatal accidents due to tractors overturning	0.6	0.5	0.7	0.8		

Compiled from a report by the Ministry of Agriculture, Fisheries and Food (1963).

Only Dervillé (1963, 1964a, 1964b) has written specifically about tractor accidents. He says that the injury is always of the crush type whether the vehicle overturns or not, and estimates that the chances of the driver being killed when it overturns backwards are one in three. Coe (1959) has commented upon the prominence of tractor accidents as a cause or injury to agricultural workers in the U.S.A. Snyder (1955) and McLaughlin and Coe (1960) have reported that tractor accidents are the principal causes of fatal farmwork injuries in the States of Kansas and Nebraska, respectively.

The purpose of this paper is to give details of 14 tractor accidents which have occurred in the area of a rural general practice, and which have been seen by my partners or myself. Thirteen cases were patients of this practice; the other was a patient of a neighbouring practice.

Fatal Cases

Case 1.—A 67-year-old married farmer was found dead in his farmyard. He was lying beneath an overturned tractor. The metal seat of the vehicle had pressed upon and crushed his chest. He had died from multiple injuries to the thorax. No one witnessed the accident.

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Case 2.—A robust and apparently fit 37-year-old married farmer had driven his tractor across a steep slippery field. It was apparent from marks left by the machine that it had slithered down the hill, and had turned round at the bottom and crashed backwards through a fence. It then fell into a road, crossed the road, and, still going backwards, travelled another 17 yards (15.5 metres). It finally overturned in marshland. The driver was found lying face downwards with the seat of the tractor pressing his face and shoulders into soft marshy ground. He was dead. No one had witnessed the accident. He had received no severe injury. A post-mortem examination produced the following pertinent information: The pericardium was completely adherent to the heart; there were small scattered haemorrhages in the epicardium; the heart was slightly enlarged—the muscle was flabby and contained small scattered patches of fibrosis—the valves and coronary arteries were normal; the lungs were congested and oedematous; the liver showed centrilobular congestion. The man had had rheumatic fever many years before, and the coroner recorded that death was due to rheumatic carditis. Whether death preceded or followed the accident was not determined.

Case 3.—A 26-year-old unmarried farm-worker had been driving a tractor with an attached straw-press and threshing machine along a narrow country road. He was found pinned beneath the rear of the tractor, which had not turned over. He was severely injured and in considerable pain, but was able to state that the tractor had slipped out of bottom gear and that his foot had gone under a wheel. It is assumed that he had jumped from the tractor on to the draw-bar with the intention of applying the brakes of the threshing machine, but that he slipped and fell under the rear of the tractor, which had moved backwards and crushed him. He was given heroin and taken by ambulance to the local cottage hospital. He had a fracture-dislocation of the lumbar vertebrae, fractured ribs, and a fractured right tibia and fibula. He was given intravenous plasma and blood. An orthopaedic unit was informed of the severity of his injuries; two registrars were sent to supervise his transport to their unit, where it was found that he also had a ruptured liver. A few days later he became uraemic and was transferred to an artificial-kidney unit. He died nine days after the accident. Besides the injuries already mentioned, he had thrombosis of the right renal artery with infarction of the kidney.

Fracture of Pelvis

Case 4.—A farmer's son aged 20 was spraying fertilizer in the fields. The weather was fine and the ground dry. He was using for the first time Davril strakes, which he had fixed to the outside of the rear wheels of the tractor to increase the brakage when he travelled downhill. As the tractor passed through a gate between two fields it traversed some particularly hard ground, and the spikes of one set of strakes were pushed into their sockets and were no longer effective. The tractor was driven to the top of a steep gradient. When the driver turned and started the descent the uneven brakage effect of the wheels became apparent. The tractor swerved, turned over, crushed the driver, and rolled to the bottom of the field. The man was carried in a blanket across three fields to a farmhouse by friends. The doctor who was summoned found him

lying on the floor of the farmhouse; he was complaining of pain in the pelvis and was bleeding from the urethra. It was apparent that he had a fractured pelvis with rupture of the urethra. He was given Pethilorfan 50 mg. intravenously and transferred by ambulance to a general hospital, where a complete rupture of the prostatic urethra was repaired. He resumed work 20 weeks later.

Case 5.—A 35-year-old married farm labourer was spreading manure on the fields while it was raining. He had driven up a gradient and was passing through a gate, where he stopped the tractor to retrieve the disconnected manure-spreader. He applied the hand brake, knocked the gear lever into neutral, and jumped off the tractor. But the vehicle was still in gear, for it continued to move forward up the slope. The rear wheel knocked the man against a gatepost, and, while continuing to rotate on the muddy surface, held and crushed him against the post for about two minutes before he was able to throw himself clear. The tractor then knocked down the gatepost and careered across the hill. The accident was witnessed by the local M.O.H., who with a companion hurried to help. They were joined soon afterwards by another doctor. The man was assisted across two fields to the nearest farmhouse, and then taken by car to hospital. He had a fracture of the left ischial ramus. He resumed work seven weeks later.

Case 6.—A farmer's son aged 20 was ploughing on a steep hillside on a fine day. There was a sudden shower of rain, which made the short grass surface slippery. The man drove the tractor down the hill. As he approached a point where the gradient became steeper he turned the tractor and raised the plough out of the soil. The tractor skidded, overturned sideways, and rolled over two or three times. The accident was witnessed by the man's brother and another man. They hurried to his help, placed him on a tractor-drawn trailer, and conveyed him for about a quarter of a mile (400 metres) to his home. He was put to bed, and the doctor was summoned. The next day he was transferred to hospital, where an x-ray examination confirmed that he had a fracture of the pelvis. He resumed work 17 weeks later.

Found Pinned Beneath Tractors

Case 7.—A 25-year-old farm labourer was ploughing the top of a high hill on a fine day. It was an isolated spot and he was alone. The wheels of the tractor sank into a bog. The tractor overturned, and the man was pinned to the ground by the seat of the vehicle, which pressed upon his left arm and shoulder. He was not missed until late evening, and the search for him did not begin until late that night. He was found at 12.30 o'clock next morning, having been lying under the tractor for about 15 hours. He was released and then conveyed down the hill by Land-rover. At the bottom of the hill he was transferred to an ambulance; he was then given a drink and intravenous Pethilorfan, and taken to hospital. He had a severe crush injury to the upper arm, which was completely paralysed but not fractured. While in hospital he became uraemic (blood urea 300 mg.) and developed a left foot-drop. There was complete recovery of function of the leg and kidneys. Two years after the accident he has a residual claw-hand. He resumed work 48 weeks after the accident.

Case 8.—A farmer's unmarried son aged 31 was ploughing a hill on a fine day. He was driving along a slippery ledge when the tractor skidded and started to slide backwards down the hill. The front wheels rose into the air, and the driver, anticipating that the tractor was going to overturn, jumped clear. He landed on his hands and feet and started to scramble away, but the tractor rolled along after him and came to rest with its rear wheels lying across his legs and its front wheels in the air. The tractor was in gear, and the engine continued to revolve. The man was lying face downwards and his legs were pressed into soft soil. He was held in this position for about half an hour, when an elderly uncle found him and summoned help. The driver's brother arrived and released him by pushing down the front of the tractor. As soon as the front wheels touched the ground the tractor drove off and was retrieved by the brother. The injured man could not move his legs. He was placed on to the plough of the tractor and driven across two fields to a farmhouse; from there he was taken by ambulance to hospital. He had extensive swelling and bruising of the lower legs. He was unable to walk for a week. He resumed work seven weeks after the accident.

Fracture of Spine

Case 9.—A farmer's son aged 19 was testing a new tractor. He drove it with an attached trailer along a track that traversed a steep hill. He wanted to turn around, so he drove the tractor off the track and uphill on to wet grass. The wheels skidded; the tractor slipped back and locked against the trailer, which broke free. The tractor overturned, rolled across the driver, and continued to roll downhill. The man was carried by his father and a friend for about 300 yards (275 metres) to the farmhouse and put to bed. He was given Pethilorfan 50 mg. intravenously by the doctor and taken by ambulance to hospital. He had a compression fracture of D 7. While he was convalescing he fell and fractured his left forearm. He resumed work 24 weeks after the tractor accident. This man was particularly lucky. When the tractor overturned it did so across a depression on the hill's surface, so that he fell into the depression and was protected from more serious injuries.

Case 10.—A 38-year-old married farm labourer was driving his tractor home. There was fog on the hills and visibility was very poor. Suddenly he saw a very steep drop ahead, and he realized that he had missed his direction and was travelling towards a precipitous slope. He braked, but the tractor continued to move forward; it reached the steep gradient, turned over, and crashed to the bottom. It fell a distance of about 100 yards (90 metres), and was a complete wreck. The man was thrown clear after the first roll. He picked himself up, and, making a detour to avoid a bull, walked about 1 mile (1.6 km.) to the nearest farmhouse, and was then taken home by car. He had a bruised neck, a fracture of the second right rib, and a retinal haemorrhage near the macula of the right eye. He resumed work 10 weeks later.

Other Cases

Case 11.—A 75-year-old married farmer was reversing his tractor uphill. It was a fine day and the ground was dry. The tractor partly overturned, and came to lie on its exhaust; it righted itself, then careered downhill and crashed through a fence and a hedge before the farmer could stop it. He climbed off the tractor, and was assisted by his son across the field to the farmhouse. He was taken to hospital by car. He had a dislocation of the right sternoclavicular joint, fractures of the sternum and right first rib, and a left-sided pneumothorax. While in hospital he developed an acute bronchitis and a superficial venous thrombosis of the right leg. He returned home four weeks after the accident.

Case 12.—A 9-year-old boy was riding in a trailer behind a tractor driven by a 40-year-old married man. The boy's finger was caught in the draw-bar and crushed. He had a compound comminuted fracture of the distal phalanx of the right ring-finger and avulsion of the soft tissues, which required a skin graft.

Case 13.—A 31-year-old married farm labourer and his employer were examining a new tractor with a hydraulic plough attachment. The employer, a 40-year-old married man, who was seated on the stationary tractor, operated a lever which lowered the plough on to the left foot of his companion and fractured the man's fifth metatarsal. The man resumed work 10 weeks later.

Case 14.—A 46-year-old married farmer was driving a tractor which was pulling a completely extended elevator. He was travelling slowly along a mountain track and was going downhill. The elevator tipped forward and pinned him to the tractor, which continued to move forward for a short distance and then tipped over into a ditch. The man was able to get up and walk home. He was seen by a doctor the next morning. He had received a fright and had a bruised back, but there were no fractures. He was not absent from work.

Road-traffic Accidents

These 14 tractor accidents occurred during the four and a half years from 30 June 1960 to 31 December 1964. A retrospective survey has also been made of all those road-traffic accidents (in which someone was injured) that occurred in this practice area during the same period. Details of these accidents were obtained from the practice records and from the local police reports of road-traffic accidents. There were 110 road

accidents, in which 187 people were involved: eight were killed, 71 were severely injured, and 108 received minor injuries. Table II indicates the relative severity of the tractor and road-traffic accidents. The sites of injury of all those who were severely or fatally injured are shown in Table III. The criterion accepted for assessing the severity of the injuries received is that which is used by the police when compiling their road-traffic accident reports and which is also used for compiling *Road Accident Statistics* (1963).

TABLE II.—Relative Severity of Tractor and Road-traffic Accidents

	Fatal	Serious	Slight	Total
Tractors	3	10	1	14
Pedal-cyclists	1	6	2	9
Pedestrians	—	9	11	20
Motor-cyclists	1	6	6	13
Pillion passengers	—	2	2	4
Car drivers	3	23	39	65
Car passengers	3	24	49	76
Total	11	80	110	201

TABLE III.—Main Sites of Injury in Fatal and Serious Accidents

	Tractors	Pedal Cyclists	Pedestrians	Motor-cyclists	Cars	Total
Fractures :						
Spine	2	—	—	1	4	7
Lower limbs	2	2	3	1	8	16
Upper limbs	1	—	1	1	8	11
Pelvis	3	—	—	—	1	4
Ribs, sternum, clavicle	3	2	1	1	3	10
Facial bones	—	—	—	—	7	7
Skull	—	4	2	2	5	13
Major soft-tissue injuries:						
Arms	1	—	—	—	—	1
Legs	2	—	—	—	—	2
Brain	—	—	1	1	12	14
Cord	—	—	—	—	1	1
Lungs	2	—	1	—	1	4
Liver	1	—	—	—	—	1
Urethra	1	—	—	—	—	1
Eye	1	—	—	—	—	1
Skin (burns)	—	—	—	1	1	2
Kidneys	2	1	—	—	—	3
Total No. of major injuries	21	9	9	8	51	98
% of total injuries	21.3	9.2	9.2	8.2	52.1	
Total No. of accidents	14	9	18	14	69	124
% of all accidents	11.3	7.3	14.5	11.3	55.6	

Discussion

If a driver is injured when a tractor overturns the chances are more than one in four that he will be killed. This extremely high death rate has been assessed from the figures given in Table I, which shows that in the four-year period ending on 30 September 1963 there were 133 fatal accidents involving overturned tractors in England and Wales. The corresponding figure for non-fatal accidents was 310. Therefore the total number of accidents in which a tractor overturned was 443 and the risk of someone being killed was in the ratio of 133 to 443, or approximately 1 in 3.5. These figures are similar to the estimate given by Dervillé (1964b) that one in three of all tractor accidents is fatal, and he also reports that 1 in 3,000 of all the tractor drivers in France is killed each year in these accidents. In my own series eight of the tractors overturned and two of the drivers died. This gives a death rate of one in four, which is very close to the national average.

The relative importance of tractor accidents as a cause of fatalities on farms is further underlined by other figures given in Table I. These show that approximately 40% of all the fatal accidents on the farms of England and Wales are caused by tractors, and that over half of these were due to tractors overturning. Only about 9% of the non-fatal accidents were caused by tractors, and only 0.5 to 0.8% of the non-fatal accidents arose from their overturning.

The relative severity and seriousness of tractor accidents can also be assessed by comparing them with road-traffic accidents. Table II shows the very high fatal and serious accident rate for tractors compared with different types of road-traffic acci-

dents. In this area about one in five of all tractor accidents was fatal, and one in four of those tractor accidents in which only the driver was involved was fatal. Such a high fatality rate makes the corresponding figures for car drivers (1 in 22) and for car passengers (1 in 25) seem comparatively small.

Different types of road-traffic accidents produce differing patterns of injury. The high rate of fractures to the unprotected head of pedal-cyclists and motor-cyclists is well known, and it is also well known that occupants of front seats of motor-cars are particularly likely to receive injuries to the head, face, and lower legs. These injury patterns are shown in Table III, but the pattern for tractor accidents appears to be different. It will be seen that a relatively high rate is recorded under tractor accidents for injuries to the trunk, and if injuries to the brain are excluded one finds that the tractor accidents were responsible for more major soft-tissue injuries than all the road-traffic accidents put together. One also finds that, although the tractor accidents represented only 11.3% of the combined tractor and road-traffic accidents, they were responsible for 21.3% of all the major injuries recorded for the two groups.

An assessment of the causes of tractor accidents can be made by examining the factors contributed by the driver, by the environment, and by the vehicle.

The Driver.—All the men were experienced tractor-drivers, and had been driving tractors for at least three years. One driver was 19 years old, four were aged 20 to 30, and all the rest were over 30. Their average age was 37, and eight of them were married men. These figures suggest that the type of person who is involved in a tractor accident is a relatively mature and married man who is an experienced driver. This type differs from the drivers usually associated with motor-cycle and motor-car accidents, where the characteristic type is the young, inexperienced, and single man. However, in two of the accidents described (Cases 9 and 14) the driver was trying out a new tractor, and on another occasion (Case 4) the driver was using for the first time a safety device that almost proved to be lethal.

Environment.—Poor visibility and fog was responsible for one accident (Case 10). A slippery surface was a contributory factor in four accidents (Cases 2, 6, 8, and 9) and an associated factor in two (Cases 3 and 5). One accident (Case 7) happened because the tractor was driven on to soft marshland. Eight of the accidents happened on steep hill-slopes, and another (Case 1) occurred on a steep track leading out from a farm-yard. Tractors are particularly likely to overturn where the gradient is steep and the grass surface wet and slippery. Tractor accidents also tend to occur in lonely and isolated spots. This increases the hazards to the casualty in two ways. Firstly, there may be a long delay before the accident is discovered and the casualty released and treated (Case 7). Secondly, the injured man may have to be conveyed across rough ground, and this is sometimes done in unusual or bizarre ways (Case 8).

The Vehicle.—The tractor is a useful but dangerous machine. Failure to maintain it in good working condition will obviously increase the hazard to the driver, but the main risk of his being killed is the likelihood of the tractor overturning and crushing him. The tractor has a high centre of gravity and is liable to overturn. Most tractors, too, have not been designed to protect the driver when this happens. A rigid cockpit or safety frames would probably give him some protection, and these are used in some countries, and according to Miedviet (1961) are standard equipment on all Russian tractors.

When a tractor is being driven it is often linked to an implement, such as a plough or a mounted spinner, which can alter the stability of the machine and increase the likelihood of an accident occurring. In ten of the accidents here described the tractor was linked in this way, and in all of these cases the attached implement was almost certainly an important contributing factor.

Summary

Fourteen accidents involving agricultural tractors are described.

If a driver is injured when a tractor overturns the chances are shown to be about one in four that he will be killed.

Tractor accidents are shown to have a much higher mortality and serious-injury rate than road-traffic accidents.

Tractor accidents produce injuries of the crush type, and the trunk is more likely to be injured than the head or extremities.

The type of man most likely to be involved in a tractor accident is one who is married, who is an experienced driver, and who is over 30 years old.

Tractors should be provided with safety frames that are strong enough to protect the drivers from being crushed should the vehicles overturn.

I wish to thank H.M. Coroner and the Chief Constable of Mid-Wales for the information obtained from the coroner's records and from the police reports of road-traffic accidents. I am grateful to my partners (Drs. T. Brittain and H. G. Davies), and also to Dr. Lee Shimmin, for allowing me to quote cases for which they were primarily responsible. My thanks are also due to the matron and staff of Llanidloes Hospital, where many of the patients were treated, and to Mr. H. Johnston Jones for translating the French papers. The help of Sgt. V. Davies and the local police constables is gratefully acknowledged.

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Organo-chlorine Pesticide Residues in Human Fat and Human Milk

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Over recent years considerable interest has been aroused by reports on studies carried out in various countries showing the presence of dieldrin and D.D.T. residues in human body fat. An official committee, after studying the available evidence, stated (Report, 1964) that, whereas there is no evidence to date that levels of these pesticides hitherto reported in human tissues do any harm or that they present any serious immediate hazard to human beings, the fact that traces of these compounds are found in so many situations is a matter of some concern. The only other surveys of human fat in the U.K. have been confined to south-east England (Hunter *et al.*, 1963 ; Robinson *et al.*, 1965), but in the present study sampling has been extended to other centres in England and Wales, and samples of human breast milk have also been examined. This study was initiated by the Advisory Committee on Pesticides and Other Toxic Chemicals, and was carried out jointly by the Ministry of Health and the Laboratory of the Government Chemist, Ministry of Technology, together with the assistance of a number of forensic pathologists and directors of human breast milk banks.

Experimental Methods and Materials

Between April 1963 and March 1964 65 samples of human perirenal fat, each of not less than 5 g., were collected by pathologists in the course of routine post-mortem examinations, and two more were taken with the agreement of patients by subcutaneous biopsy. The specimens were placed in prepared glass containers, sent to the Laboratory of the Government Chemist, and stored at approximately -20° C. prior to analysis. Over the same period 19 samples of human breast milk were collected in quantities of about 100 ml. when surpluses were available at milk banks. These also were sent to the Laboratory of the Government Chemist in prepared glass containers and stored at about 3° C. prior to analysis.

Samples of fat were first freed from any adhering non-fatty material, washed with distilled water, and dried with cellulose tissue. Residues of organochlorine pesticides were estimated in fat and milk by procedures previously described (de Faubert Maunder *et al.*, 1964a, 1964b), using two gas chromatographic columns of differing polarities for each sample. When the levels of *pp'*-D.D.E. and *pp'*-D.D.T. were sufficiently high, further confirmation of the results was obtained by paper chromatography (Evans, 1962).

Results

Human Fat

The results for D.D.E., D.D.T., total D.D.T. equivalent, total B.H.C. isomers, and dieldrin (H.E.O.D.) in human fat, expressed in parts per million, are given in Table I. This table omits results for one subject in whose fat exceptionally high *pp'*-D.D.E. and *pp'*-D.D.T. levels, 26 and 25 parts per million respectively, were found and who on further inquiry proved to have been a recent immigrant from Pakistan. The total D.D.T. equivalent has been calculated by addition of the *pp'*-D.D.T. equivalent of the *pp'*-D.D.E. found to the level of *pp'*-D.D.T. found as such. Since *pp'*-D.D.E. is relatively non-toxic, the total *pp'*-D.D.T. equivalent figure may be regarded as the maximum indication of any hazard from this pesticide. Normally the alpha, beta, and gamma isomers of B.H.C. were found in all samples, but beta-B.H.C. usually predominated to the extent of about 90% of the total B.H.C. Beta-B.H.C. is reported to have a lower acute toxicity but a higher chronic toxicity than the other isomers (Lehman, 1951 ; Martin, 1961). A trace of heptachlor epoxide, in no case exceeding 0.1 part per million, was also detected in most samples.

These results have been considered statistically. As noted in the earlier survey, the distribution of *pp'*-D.D.T. and dieldrin levels is skew ; for this reason individual results have been