A Retrospective Study on Measures Taken to Prevent Over the Embankment Motor Vehicle Crashes in the Hoopa Area of Northern California

Hupa Health Association, Emergency Medical Services.

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A RETROSPECTIVE STUDY
ON MEASURES TAKEN TO PREVENT
OVER THE EMBANKMENT MOTOR VEHICLE CRASHES
IN THE HOOPA AREA OF NORTHERN CALIFORNIA

SUBMITTED BY
DAVID C. SHORT
HUPA HEALTH ASSOCIATION
EMERGENCY MEDICAL SERVICES
A RETROSPECTIVE STUDY
ON MEASURES TAKEN TO PREVENT
OVER THE EMBANKMENT MOTOR VEHICLE CRASHES
IN THE HOOPA AREA OF NORTHERN CALIFORNIA

------------------------------OBJECTIVES-------------------------------

1. To analyse the effectiveness of a simple surveillance system.

2. To evaluate that surveillance systems' ability to predict over the embankment motor vehicle crash clustering.

3. To demonstrate the severity of the over the embankment crash problem in the Hoopa area.

4. To develop a baseline with which to continue to evaluate the problems of over the embankment crashes after the initiation of corrective measures.

5. To demonstrate one means of bringing pressure to bear on agencies responsible for the reduction of roadside hazards.

6. To compare the differences between the types of injuries sustained in the "average" over the embankment vehicle crash and those sustained in crashes which don't leave the roadway.

7. To compare over the bank crash sites for common features which may lead to the crash, or exacerbate the injuries sustained in the crash.
DEFINITIONS

1. **Over the Embankment Motor Vehicle Crashes:**
   (Over the Banks, OTBS'); Any motor vehicle crash which results in that vehicle leaving the roadway and down an embankment.

2. **Embankment:**
   Any terrain feature beyond the shoulder of the road with a negative gradient sufficient to prevent the return of a vehicle to the roadway during a crash.

3. **Vehicle:**
   Any rubber tied vehicle including but not limited to: Passenger vehicles, light trucks, commercial trucks of all sizes, motor cycles and motor driven cycles. This includes all-terrain vehicles and four wheel drive vehicles which may have been operated illegally on the roadway during the time of the crash.

4. **Roadway:**
   The roadways mentioned for the purposes of this study will be limited to those state highways, local roads, and major spur roads within the approximately 50 mile radius which constitutes the Hupa Health Association emergency medical services response zone.

5. **Fatality:**
   Any injury or combination of injuries that results in death within one year of the crash (1)

INSTRUMENTS FOR RECORDING AND CLASSIFYING DATA

1. **Hupa Health Association Emergency Medical Rescue Reports.**

2. Site visits utilizing video equipment to visually determine slope, embankment features, shoulder widths, skid mark patterns, (No actual measurements were taken at any of the sites).

3. Review of the local newspaper "The Kourier" obtained from Library files.
--------INSTRUMENTS FOR RECORDING AND CLASSIFYING DATA (CONT.)--------

4. California Department of Transportation post mile identification lists.

5. U.S. Geological Survey maps (topographic)

6. Interviews with EMS personnel.

7. Personal familiarity with most of the cases as on scene paramedic/rescuer.
1. Fatality: "fatal injury": Federal Highway Administration and the National Center for Health Statistics.

   "Low-Cost Countermeasures for Ameliorating Run off Road Crashes.
   "Washington D.C.: Insurance Institute for Highway Safety
   August 1982

   "The Injury Fact Book"
   Insurance Institute For Highway Safety
   1984

   "Roadside Hazards on Non-Freeway Facilities,"
   Transportation Research Record 610, Transportation Research Board,
   1976

5. Oglesby, Clarkson H.
   "Highway Engineering"
   Third edition
"About 8000 occupants are killed each year in vehicles that overturn. Death rates for such "rollover" crashes, which are highest in the mountain states are related not only to the gradient and curvature of roads, but also to the absence of recovery areas and guardrails where vehicles leaving the roadway can roll down an embankment." (2)

"Rollovers have high death-rates; more than twice the rate for non-rollovers, this is partly because a much larger proportion of occupants (8 percent) are ejected from their vehicles in rollovers, compared to only 0.4 percent ejected from vehicles that do not roll over. Ejection is associated with a 25-fold increase in the risk of death: 259 deaths per 1,000 people ejected compared to about 10 per 1,000 among those not ejected. The ability of a vehicle to keep occupants inside when it crashes (whether or not the vehicle overturns) is a major determinant of the likelihood of severe injury or death." (3)

"The ratio of occupant deaths to injuries increases dramatically with the posted speed limit, from less than 4 deaths per 1,000 injuries where the limit is 30 mph or less, to 25 per 1,000 where the limit is 55 mph." (3)

Hall et al. (4) studied the nature of single vehicle accidents involving fixed objects along the roadside and found that these accidents occurred most frequently during darkness and/or adverse weather, on poor pavement, and on horizontal curves." (5)

Given the above information, it is not surprising that the area around Hoopa California has a very high severe injury and death rate: A high percentage of the crashes occur over the bank and result in extended rollover type crashes which often eject the occupants. It is common to find some of the occupants of an over the bank standing on the side of the road claiming to have "jumped out" early in the crash. Often these people will have only minor injuries while those who remained in the vehicle longer are ejected with more force and receive much more severe injuries.
Highway conditions in the Hoopa area are universally poor. Crooked roads with narrow shoulders and rough surfaces are the rule. Elevation of the roadway changes rapidly. Weather is inclement during much of the year with mud and debris scattered across the roadway after each rain, freeze, or thaw. Large truck traffic is frequently heavy. These trucks spill fuel and oil over the roadway causing slick surfaces especially during the first rains after a dry spell. Large vehicles on steep grades cause congestion problems going up, and speed control problems coming down. The average speed limit is 55 mph.

Hoopa, being an Indian reservation has a very high rate of unemployment (85%). Many of the vehicles are substandard older cars in questionable repair. Four wheel drive vehicles are popular and it is also popular to jack them up and put oversized tires on them raising their center of gravity causing poor handling characteristics in the turns.

The nearest definitive medical care is 52 miles from downtown Hoopa, which translates into about 2 hours from the more remote areas of the response zone.

Along certain stretches of these roads are areas known locally as "Bluffs". These are areas where the road traverses a particularly steep hillside, usually high above the river. Because they cross such steep terrain, these bluffs tend to be extremely narrow, crooked, and rough. They have more than the usual amount of debris problems, and usually very narrow shoulders, or no shoulders at all. The bluffs are often over 500 feet high.

For many years, the only protection to vehicles traveling the bluff areas were logs which were anchored along the roadside edge forming a low barrier. These prevented a vehicle from being sucked over by a carelessly placed outside wheel, but they did little to prevent vehicles from plunging over when the log barriers were hit with any force, or at a more acute angle.

Although this study documents all over the bank crashes that records exist for from the years 1979 through 1988, it is the bluffs which are the primary focus for improvement.

This study will demonstrate that the bluff areas are over-represented for fatal and critical injuries from all motor vehicle crashes within our area. It will further show that the nature of these fatal injuries is primarily major multiple systems trauma.
As EMS Coordinator and also as a rescuer, I have long been interested in the problem of over the bank vehicle crashes. The bluffs in particular presented a major problem because of their height, extreme steepness, and the difficulty and dangers associated with performing technical rescue as well as advanced life support below loose rocks.

For the first five years, the entire plan was based on accessing the patient, removing him from the danger of falling rocks, stabilizing him if possible, and extricating him from the hillside.

These efforts met with limited success. Time and the severity of the injuries always worked against us. Usually if the patient was in critical condition when we got too him, he was dead by the time we reached the hospital.

These patients needed a trauma surgeon and whole blood within one hour of their injury, and frequently the total time of the incident would exceed 3 hours.

I want to emphasize here that EMS has played an important part in patient survival in our area, being forced to deal with these extremely complex and hazardous rescues forced the entire regions' EMS into vast improvements. Those improvements have had far reaching consequences throughout our response zone.

However; in patients with major multiple systems trauma, the chances of survival were very slim, and continue to be at this time.

As I began to see the futility of treating these multiple trauma patients after the fact, I became more sensitive to the idea that prevention is the only real answer. In this case, we had done all we could for the patients and our success ratio hadn't changed at all.

I began a program of video taping the areas where our most severe problems were occurring. I went out in uniform with an ambulance unit, and taped road features, embankments, shoulder widths, and skid marks after crashes. I began this program in 1985.
My plan was to come up with a strong argument that I could take to Cal-Trans which would help speed up the process of building barriers to the embankments along the high risk areas.

Coincidentally with my filming campaign, Cal-Trans found itself at fault in two substantial lawsuits: one for inadequate road width; one for actions taken by their crew at the scene of a diesel spill which caused a double fatality in the North Hoopa Bluffs. There was a substantial financial settlement by Cal-Trans in each of these suits.

Also in 1985, a Mr. Jim Siebert, a Cal Trans employee in Eureka, California, developed a means of anchoring guardrails underneath the roadway. He used cantilevered steel I beams set into ditches under the roadbed, to these he bolted steel risers on which to mount the rails. This design won him an award and also made possible the massive guardrail project which occurred beginning in late 1985 and continuing through 1986.

In addition to the guardrails, some areas received very extensive widening and roadbed improvement. Some of these improvements are continuing today within our response area.

------------------------QUESTIONS------------------------

1. Have the guardrails affected the fatalities associated with over the bank motor vehicle crashes?

2. Have the guardrails caused other problems such as increased incidence of head-on crashes to occur?

3. Will the cantilevered guardrail design prove to be sturdy enough to withstand major impacts?

4. Are there still unprotected cluster sites and potential cluster sites which have not been discovered?
CONCLUSIONS

Based on the ongoing surveillance of data since installation of the guardrails, there is a very strong correlation with the date of installation, and the downswing of over the bank vehicle crashes (see attached).

There is no evidence to suggest any upswing in head on crashes exacerbated by the guardrails. There has only been one since 1985, and guardrails were not a factor.

To date, the cantilevered design of railing seems to be holding up very well. There is much evidence of "brushing" impacts without any failures. In addition, they are able to take impacts by tumbling rocks without showing any obvious signs of weakening. I have yet to see any solid impacts on these rails, but I strongly suspect that they will hold up better than wood.

There are definitely still many unprotected embankments throughout this region. There are also some areas in which guardrails weren't installed completely around dangerous turns, leaving a gap in the area of the curve which is very likely to collect vehicles. These areas will continue to be especially hazardous until they are improved. However, the worst of the areas have been vastly improved.
THE OBJECTIVES OF THIS STUDY WERE MET;

A SIMPLE, CHEAP AND LOW TECHNOLOGY SURVEILLANCE WAS UNDERTAKEN WHICH WAS ABLE TO ACCURATELY PREDICT OVER THE EMBANKMENT VEHICLE CRASH CLUSTERING. THIS SORT OF "HASHMARK" EPIDEMIOLOGY COULD BE EASILY APPLIED BY LAY PEOPLE WITH VERY LITTLE RESOURCES. THE ONLY PREREQUISITE IS ACCESS TO USEFUL INFORMATION. IN MY CASE, IT WAS EXTREMELY HELPFUL TO ME THAT I WAS DIRECTLY INVOLVED IN THE EMERGENCY SERVICES RENDERED AT THE SCENE OF THESE CRASHES. IT GAVE ME A MUCH CLEARER PICTURE OF EXACTLY WHAT THE PROBLEMS WERE. IT ALSO ALLOWED ME TO BEGIN TO MAKE COMPARISONS IN MY OWN MIND REGARDING EXACTLY WHAT WAS CAUSING THE PROBLEMS. I WOULD SUGGEST THAT A LITTLE TIME SPENT TRACKING DOWN PEOPLE WHO HAVE PERSONAL KNOWLEDGE ABOUT THE PARTICULAR PROBLEM THAT YOU ARE INTERESTED IN, WILL SAVE YOU A LOT OF TIME AND ENERGY, AND WILL GET YOU OFF TO A GOOD START WITHOUT TOO MANY DELAYS AND FALSE STARTS.

BY UNDERTAKING THIS SURVEILLANCE, I WAS ABLE TO DEMONSTRATE HOW SEVERE THE PROBLEM REALLY WAS IN OUR AREA, AND HOPEFULLY MAKE IT MORE VISIBLE TO THOSE PEOPLE WHO HAVE THE RESOURCES AND RESPONSIBILITY TO CORRECT IT. I SEE THAT THE VISIBILITY OF THE PROBLEM IS ONE OF THE MOST IMPORTANT PARTS OF THIS PROGRAM. HAZARDS NEED TO BE BROUGHT OUT INTO THE OPEN SO THAT THEY CAN BE IDENTIFIED, RESEARCHED, AND CORRECTED. THE NATION NEEDS TO BE MADE AWARE OF THE HUGE INJURY PROBLEM. ANY METHOD OF GETTING THAT POINT ACROSS SHOULD BE A PRIORITY.

IN OVER THE EMBANKMENT CRASHES, MULTIPLE SYSTEM TRAUMA (MAJOR TRAUMA TO MORE THAN ONE ESSENTIAL ORGAN SYSTEM) IS ALMOST ALWAYS THE KILLER. IN MOST OF THE

IN THOSE RARE CASES THAT A SEATBELT IS WORN, CHANCES FOR SURVIVAL SEEM TO BE MUCH HIGHER. (ANECDOTALLY) THERE IS A STORY TOLD TO ME BY THE SURVIVORS ABOUT THE WOMAN WHO LITERALLY DROVE HER CAR TO THE RIVER OVER ONE OF THE LESS EXTREME BLUFF AREAS. NEITHER SHE NOR HER 65 YEAR OLD HUSBAND WERE INJURED.

FINALLY, MY OBSERVATIONS PREDICTABLY AGREE WITH THE OTHER EXPERTS REGARDING COMMON FEATURES IN OVER THE BANK CRASHES:

ENVIRONMENT: DOWNHILL GRADE FREQUENTLY FROM BOTH DIRECTIONS, SHADY AREA THAT STAYS SLIPPERY MUCH OF THE YEAR, POOR ROAD SURFACE AND DEBRIS ON THE ROADWAY COMMON, POOR VISIBILITY, AND INADQUATE MARKING OF THE TURN, CHANGABLE WEATHER, SHARP TURNS WITH NARROW SHOULDERS AND STEEP EMBANKMENTS.

DRIVER: YOUNG, SPEEDING FOR CONDITIONS, FAMILIAR WITH THE ROAD, LOCAL, MALE, IMPAIRED BY DRUGS, ALCOHOL, OR SLEEPINESS.

PROFILE: USUALLY GOES OFF THE RIGHT SIDE OF THE ROAD DURING THE CRASH, EITHER OVERCORRECTS MORE THAN ONCE, OR SHOWS CENTRIFICAL SKID PATTERNS ASSOCIATED WITH TOO MUCH SPEED FOR TRACTION.
It is the authors hope that this report will interest some of you in the modification of environmental factors as a useful alternative to trying to teach people how to protect themselves.

One thing about a guardrail, if you need it and it's there, you'll be glad that it was. If you don't need it, it'll be there for the next guy.

David Short
EMS Coordinator
Hupa Health Association
April 1989
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<td>Blue Slide</td>
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<td>South Fork Bridge</td>
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(ATTACHMENT A.) Scatter-plot of Bluff area deaths and injuries by year of occurrence

D = Death
C = Critical Injury
M = Minor Injury

Adjacent letters indicates more than one patient

Records not available for prior to 1980 personal experience only

\( G = \text{Guard rail impact w/critical injuries} \)
## CHARACTERISTICS OF CLUSTER SITES

<table>
<thead>
<tr>
<th>SITE</th>
<th>SPEED LIMIT</th>
<th>EMBANKMENT GRADE</th>
<th>SLOPE OF ROADWAY</th>
<th>SHOULDER WIDTH</th>
<th>TYPICAL CRASH PROFILE AND OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH HOOPA BLUFFS (16.98)</td>
<td>NOT MARKED</td>
<td>EXTREME</td>
<td>SLIGHT NORTHERN RISE</td>
<td>EXTREMELY NARROW (LOGS)</td>
<td>SLIPPERY CONDITIONS, EXCESS SPEED 500 FOOT FALL OR MORE INTO RIVER</td>
</tr>
<tr>
<td>BLUE SLIDE HIGHWAY 96</td>
<td>40 IN TURN</td>
<td>EXTREME</td>
<td>LEVEL</td>
<td>LESS THAN 10 FEET</td>
<td>VEHICLE ENTERS FROM THE NORTH AT HIGH SPEED TURNS RIGHT, GOES LEFT INTO RIVER</td>
</tr>
<tr>
<td>SOUTH HOOPA BLUFFS</td>
<td>UNKNOWN</td>
<td>EXTREME</td>
<td>SLIGHT NORTHERN DOWNHILL</td>
<td>NONE (LOGS)</td>
<td>VEHICLE ENTERS FROM THE SOUTH, TURNS LEFT, GOES RIGHT OVER THE BANK INTO RIVER 300 FEET BELOW, DEBRIS A FACTOR AT THIS SITE</td>
</tr>
<tr>
<td>EAST FORK HIGHWAY (299)</td>
<td>TRUCKS LESS THAN 40 MPH</td>
<td>VERY STEEP</td>
<td>MODERATE EASTERN DOWNHILL</td>
<td>NARROW WITH GUARDRAILS</td>
<td>LOADED TRUCK ENTERS FROM THE WEST GOING TOO FAST, TURNS LEFT, GOES RIGHT, THROUGH GUARDRAIL INTO 30 FOOT DEEP DITCH, ICY CONDITIONS</td>
</tr>
<tr>
<td>MILE POST (2.1) TRINITY COUNTY (299)</td>
<td>55</td>
<td>VERY STEEP</td>
<td>DOWNHILL FROM EAST AND WEST</td>
<td>NARROW AT APEX OF THE TURN DIRT BERM</td>
<td>WET ROADWAY AT A SLIDE, MUD, VEHICLE GOES OFF ROAD AT INSIDE OF TURN AND DOWN 200 FEET</td>
</tr>
<tr>
<td>MCDONALDS BLUFFS 55 (299) BURNT RANCH AREA</td>
<td>EXTREME</td>
<td>DOWNHILL FROM EAST AND WEST</td>
<td>NARROW PAST APEX OF TURN</td>
<td>WEST BOUND VEHICLE TURNS RIGHT, GOES RIGHT THROUGH THE GAP IN THE GUARDRAIL GAP IN GUARDRAIL DOWN 300 PLUS FEET INTO A STEEP CREEK BED</td>
<td></td>
</tr>
<tr>
<td>SOUTH FORK ROAD TRINITY COUNTY</td>
<td>NOT MARKED</td>
<td>VERY STEEP WOODED</td>
<td>DOWNHILL FROM THE EAST</td>
<td>10-15 FEET</td>
<td>WEST BOUND VEHICLE DOESN'T SLOW FOR THE SHARP POORLEY MARKED TURN AT THE BOTTOM OF THE HILL, TURNS LEFT, GOES STRAIGHT AT HIGH SPEED</td>
</tr>
</tbody>
</table>

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**ATTACHMENT B.**
TRIPLE FATALITY NEAR WEITCHPEC
Missing Man Found; 2 Fatalities in Hwy. 96 Crash
Falling Rocks Cause Crash; One Car Falls Nearly 300 Ft.
Slide on Hwy. 233 Claims CalTrans Man
Car Into River; Two Fatalities
Fatality at 2.1 Slide
Woman Dies After Vreck on McIntosh
Skidder Operator Killed
Pot Ejected From Car Into Creek Rescued By Camper
Five Injured in Wreck on Highway 96

Bluffs Claim 3 Victims Near 17-Mile Post
Orleans Lady Killed
FATALITY Near Orleans
Six Persons Injured Monday Near Weitchpec
Redding Man Killed in "299" Crash

SCHOOL BUS INCIDENT
1 Fatality in Accident on Ho-Road; 2 Others Injured

SCHOOL BUS ACCIDENT CASUALTIES
Freshman Student and Truck Driver Are Fatalities;
36 Injured Steadily Improving