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Final Administrative Summary Rural Preventable Mortality Study

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16. Abstract

All trauma deaths (n=154) from two rural (population density 6.08/sq. mi.) socio-demographically matched study areas, covering a one year time span, were analyzed to determine the rate of preventable death and inappropriate care.

The overall preventable mortality rate was 17%, with 10 preventable deaths in Area A (11.5%) and 16 preventable deaths in Area B (23.9%). Preventable deaths were identified by phase of care with 2 (7.7%) occurring as a result of deficiencies in the prehospital phase, 14 (53.8%) due to inadequacies of care in the emergency department and 10 (38.5%) occurring in the post emergency department.

The distribution of inappropriate care rendered for all deaths (preventable and non-preventable) in each phase of care was 15.7% in the prehospital phase, 62.8% in the emergency department and 21.6% post emergency department. Errors or omissions in care occurred in airway management (n=8), hemorrhage control (n=3), delay in treatment (n=11) and improper management of chest trauma (n=15).

The etiology of trauma showed a significant rate of motor vehicle related trauma, with 72 deaths as a result of vehicle crashes, 10 from auto-pedestrian incidents, 5 from motorcycles crashes and 4 involving motor vehicle/train collisions. Of the motor vehicle crashes, 45 (63%) involved single vehicle rollovers with (51%) of those involving the ejection of one or more of the fatalities.

Additional study of rural preventable trauma mortality and the continued refinement of this analytical process is recommended. Findings of this and other rural studies indicate a need to further develop and enhance trauma care systems, particularly in rural areas of the United States.

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The Problem Identification Process, Objectives, Analytical Strategies and Methodology

Problem Identification Process

Montana, like many other rural states, does not have a standardized system of trauma care. The death rate from injury in Montana is significantly higher for all age groups (72/100,000) than the national norm (62/100,000) and dramatically higher in certain age groups and among Native Americans (200/100,000). These figures have not caused undue alarm in either the general population or the medical community, since they tend to be dismissed as resulting from geographic or sociologic phenomena which makes them "unpreventable." It is widely assumed that people die from injury in Montana because their injuries occur in remote locations and that the rate of death is substantially influenced by the lifestyles and occupations of the population. Little credibility is placed in the possibility that the increased death rate is directly attributable to deficiencies in the medical care system. Therefore, little emphasis has been placed on developing an organized system of trauma care.

Two general methods for determining the rate of preventability had been previously reported in the literature; those being, blinded clinical chart review and autopsy methods. After lengthy discussion and debate we chose a combination of the two processes and agreed *to include any case whereby preventability could be determined from any source of data.*

Further, while previous studies had largely excluded those deaths which occur outside of the hospital, we determined that if we were to evaluate the total scope of the EMS system, then issues of discovery, access and prehospital care also needed to be examined. Therefore the final study groups were *all deaths from mechanical trauma occurring in either study area during the period of time from October 1, 1990 - September 30, 1991, so long as sufficient data existed from any singular or collective source(s) so as to be able to determine preventability*. Exclusions were made for: non-mechanical trauma, insufficient data and suicide attempts who did not survive to the hospital.

The Rationale for the Selection of this Process

This study design was chosen based on several considerations. The contract required a minimum of 60 cases in each of two study areas over a 12 month period of time. It also required that a general determination of which phase of care led to untoward outcomes be made. It was, therefore, necessary to examine every possible case to ensure an adequate sample size and to examine all sources of information which might reveal the circumstances surrounding the demise of each patient.

Chart review requires both access to, and a consistency in the documentation of, each chart. These factors can largely be assured in confined settings involving a small number of hospitals with largely similar staffing patterns and capabilities. This study involved the potential for accessing and retrieving data from some 28 hospitals, most of which (89%) do not have full-time emergency department physician staffing. The other major limitation of the chart review process is that it would preclude examination those cases which did not survive to the hospital. The issues

surrounding inter-rater reliability and inherent biases in the review process are also heightened by the absence of autopsy information.

The autopsy method of determining preventability is dependent upon both the availability of autopsy records and the quality of those records. There is not a mandatory autopsy statute in Montana. The best estimate at the outset of the study (based upon gross review of a sample of the previous year's death certificates) was that the autopsy rate would be 60-65% [including both internal and external examinations]. It was also suspected that those cases which were likely to have been autopsied would be those involving homicide or suicide. This had the potential to skew the outcome due to a preponderance of penetrating trauma which is not typical of rural patterns of injury. Likewise, since the autopsies which were conducted would be completed by a variety of personnel with varying degrees of training and interest, it was presumed that the consistency of the autopsy data would vary dramatically.

These considerations served as the rationale for our selection of a multi-method process for determining the rate of preventable trauma death and the phase of care associated with untoward outcomes.

Research Plan and Methodology

GOAL: Organize and conduct a Rural Preventable Mortality Study in Montana.

OBJECTIVES:

A. Obtain detailed information on at least 60 deaths from trauma in each of two similar rural medical catchment areas in Montana.

B. Examine the effectiveness of the prehospital treatment and transport system and the ability of hospital medical personnel to identify and appropriately treat trauma patients in a rural setting.

C. Identify and order problems in rural EMS systems and contrast these with problems identified in previous studies conducted in urban EMS systems.

D. Develop and validate a research methodology and uniform data collection instrument which can be readily replicated and utilized in other rural areas of the United States.

E. Identify EMS/Trauma care system problems in Montana which will provide data to support regional and state level policy changes to upgrade trauma care capabilities in prehospital, hospital and inter-hospital transport systems.

Case Review Process:

Abstracts of each case, blinded for care giver and place of care, were prepared for distribution to the case review panel. Two panel members were then provided with an abstract for each case. One of those two panel members was designated as primary reviewer of the case. Upon request, a complete case file was provided to the primary reviewer. Each case was presented to the entire panel by the primary reviewer with added comments provided by the secondary reviewer. A single reviewer (the out of state trauma surgeon) reviewed all cases and served as arbiter and chairman of the panel. Where disagreement between two reviewers existed regarding preventability categorization or appropriateness of care a consensus panel agreement was reached in order to categorize the case. Unanimous consensus occurred in the majority of cases (greater than 90%).

Statistical analyses of study data were conducted by project staff under the direction of the project epidemiologist. Statistical methods included: frequency distribution, cross tabulation and statistical tests as considered appropriate (significance level was set at .05). In addition, specific statistical methodologies related to mortality outcome studies, i.e. TRISS and the calculation of P_s values were conducted. The majority of these analyses were completed by the resident reporting functions contained within the System Trauma Register and the underlying dBase IV language. A portion of the additional administrative data was entered into a separate free-standing data base (MS Works) for analysis. Additional fields could have easily been added to the System Trauma Register at the outset which would have precluded the establishment of this administrative data base.

An Overview of the Research Results, Conclusions and Implications of the Study

There were 3085 deaths from all causes in the combined study areas during the study period. 286 (9.3%) of these were related to trauma. 132 of these trauma-related deaths were excluded from the study, 110 (83%) due to non-mechanical trauma being the cause of death and 22 (17%) as a result of insufficient information available to determine preventability. Therefore, 154 cases, representing 54% of all trauma related deaths were reviewed and judged for preventability. There were 87 cases, (56%) from study area A and 67 cases (44%) from study area B. Of all 154 study cases, 82 (53%) had no autopsy or an external autopsy only. These were included for review as other information sufficient to determine preventability and appropriateness of care was available.

There were 115 (75%) male and 39 (25%) female. Mean age was 40 (3-95), 78% were caucasian, 19% Native American and 3% other. Corresponding distribution of these races in the general population is 93%, 6% and 1% respectively. 81% of injuries were unintentional, 19% were intentional. Of the intentional injuries, 50% were homicides and 50% suicides. 81% of all fatalities sustained blunt injuries, 19% penetrating. Mechanism of injury included: 72 (46.8%) motor vehicle crashes, 26 (26.9%) gunshot wounds, 20 (13%) falls, 10 (6.5%) pedestrians struck, 5 (3.2%) motorcycle collisions, 5 (3.2%) industrial, 4 (2.6%) involved agricultural [including both livestock animals and machinery], 4 (2.6%) involved trains, 4 (2.6%) stab wounds and 4 (2.6%) involved aircraft (Table 1).

Table 1: Mechanism of Injury

Mechanism	Area A #	Area A (%)	Area B #	Area B (%)	Total #	Total (%)
Motor Vehicle Crash	47	(54.0%)	25	(37.3%)	72	(46.8%)
Fall	9	(10.3%)	11	(16.4%)	20	(13.0%)
Motorcycle Crash	4	(4.6%)	1	(1.5%)	5	(3.2%)
Pedestrian Struck	1	(1.1%)	9	(13.4%)	10	(6.5%)
Gunshot Wound	16	(18.4%)	10	(14.9%)	26	(16.9%)
Stab Wound	2	(2.4%)	2	(3.0%)	4	(2.6%)
Agricultural	3	(3.4%)	1	(1.5%)	4	(2.6%)
Other	5	(5.7%)	8	(11.9%)	13	(8.4%)
Total	87		67		154	

Information was obtained on alcohol use in 79% of all cases. Of these, alcohol use was associated with 39% of all cases and 53.5% of motor vehicle related cases. 35% of all fatalities studied were legally intoxicated and 49% of those who were drivers of motor vehicles or pedestrians struck were legally intoxicated. For motor vehicle occupant fatalities where information on restraint use was obtained (36/72), 14% were restrained and 86% unrestrained. Of the motor vehicle fatalities, 63% involved one vehicle rollovers and 51% of the decedents were reportedly ejected from the vehicle.

Of the 154 cases studied, 5 (3.3%) were judged frankly preventable and 21 (13.6%) potentially preventable. This gives an overall preventability rate of 17% (26/154). Overall preventability was 12% in Area A and 24% in Area B ($p = .07$) (Table 2). Considering only hospital deaths (N=76) overall preventability was 32%; with 22% in Area A and 45% in Area B ($p = .06$) (Table 3).

Table 2: Preventability For All Cases (N = 154)

Preventability	Area A #	Area A (%)	Area B #	Area B (%)	Total #	Total (%)
Frankly Preventable	2	(2.3%)	3	(4.5%)	5	(3.3%)
Potentially Preventable	8	(9.2%)	13	(19.4%)	21	(13.6%)
Total Preventable	10	(11.5%)	16	(23.9%)	26	(17.0%)
Non-Preventable	77	(88.5%)	51	(76.1%)	128	(83.0%)

Table 3: Preventability for Deaths Occurring in the Hospital (N = 76)

Preventability	Area A #	Area A (%)	Area B #	Area B (%)	Total #	Total (%)
Frankly Preventable	2	(4%)	3	(10%)	5	(7%)
Potentially Preventable	8	(18%)	11	(35%)	19	(25%)
Total Preventabe	10	(22%)	14	(45%)	24	(32%)
Non-Preventable	35	(78%)	17	(55%)	52	(68%)

Associated system access delay, either delay in discovery or excess response time was found in 46 (59%) of prehospital deaths. Excessive scene times (greater than 20 minutes) were found in 15 (23%) of the 64 cases where such data were available.

Preventability stratified by survival time, age and cause of death is presented in Tables 4 & 5. In the 77 cases where TRISS analysis was possible, 55.6% of deaths judged by the review panel to be preventable had a $P_s > .50$. For those cases judged non-preventable, 84.7% had a $P_s < .50$.

Table 4: Preventability by Survival Time and Age.

Preventability	Time to Death <48 hr.		Time to Death >48hr.		Age <55 yr.		Age >55 yr.	
Frankly Preventable	1	(20%)	4	(80%)	1	(20%)	4	(80%)
Potentially Preventable	16	(76%)	5	(24%)	11	(52%)	10	(48%)
Total Preventable	17	(65%)	9	(35%)	12	(46%)	14	(54%)
Non-Preventable	118	(92%)	10	(8%)	100	(78%)	28	(22%)
Total	135	(88%)	19	(12%)	112	(73%)	42	(27%)

Table 5: Preventability and Cause of Death.

Preventability	CNS # (%)	Airway # (%)	Hemorrhage # (%)	Sepsis # (%)	Indeterminate # (%)
Frankly Preventable	2 (40%)	2 (40%)	0 (0%)	1 (20%)	0 (0%)
Potentially Preventable	2 (09%)	8 (38%)	9 (43%)	1 (05%)	1 (05%)
Total Preventable	4 (15%)	10 (34%)	9 (38%)	2 (08%)	1 (04%)
Non-Preventable	81 (62%)	11 (09%)	32 (25%)	2 (02%)	2 (02%)
Total	85 (55%)	21 (14%)	41 (26%)	4 (03%)	3 (02%)

The rate of inappropriate care rendered for the entire sample was 33% (51/154). 64% of hospital deaths (49/76) received inappropriate care. The rate of inappropriate care for hospital deaths differed between study areas, 53% in A and 81% in B (p=.03).

The majority of inappropriate care (45%) was related to respiratory problem management [including airway control and chest trauma management] and was most prevalent in the emergency department phase of care. 63% of cases with evidence of inappropriate care showed deficiencies occurring in the emergency department. This trend held true regardless of whether the death was judged preventable or non-preventable.

Conclusions:

The preventable trauma death rate in Montana does not seem to differ from those previously reported in areas without an organized system of trauma care. An overall preventability rate of 17% is low in comparison to other studies. However the previous studies considered only hospital deaths. When this variable is controlled for, the 32% preventability rate in Montana is similar to those reported in prior studies.

Prior to this study, it had been widely speculated that the preventability rate in rural areas would be significantly higher due to extended distances and time to care variables. This does not appear to be the case. It may be that extended time/distance factors serve as a natural triage system in which those with non-survivable injuries often die before any intervention (either prehospital or hospital). This factor may account for the lower preventability rate when all deaths (prehospital and hospital) are considered.

Issues surrounding delays in discovery, dispatch and extended response times are common in the rural environment. These were present in nearly 60% of prehospital deaths in this study. The delays which seemed to contribute most directly to untoward outcomes tended to be measured in hours rather than minutes. That is to say a motor vehicle would leave the roadway in the early morning hours (3:00 a.m.) and would not be found by another passing motorist until sunrise later that day. In these instances, access to telephones, other communication devices or EMS personnel seemed to be less of an issue than the fact that so few people travel various stretches of secondary highways late at night. From these rough data, it seems that automatic detection and signaling devices on the vehicle itself would be far more critical in the rural areas than routine installation of periodic call boxes on the highway or an increase in prehospital manpower.

It has also been widely conjectured that the prehospital phase of care may play a more important role in the outcome of trauma patients in rural areas due to extended transport times. Stratification of results by phase of care indicates that the problem is far more often the result of inadequate care once the patient reached the hospital rather than as a result of sub-standard care in the prehospital phase. Deficiencies noted in the prehospital phase included: absence of a clear and definitive protocol regarding field resuscitation of traumatic cardiac arrests occurring prior to the arrival of the prehospital personnel, failure to adhere to the loosely structured protocols which are in place, inadequate documentation of all aspects of care in the prehospital phase and increased scene time for ALS procedures. Preventable deaths in the prehospital phase were almost entirely due to inadequate airway management.

There were a number of deficiencies noted in the hospital phase of care. Predominately these occurred in the Emergency Department. This was the site where the greatest number of preventable deaths and cases of inappropriate care occurred to the entire study. As in the prehospital phase, these deficiencies were related to deviation from principles of airway management and respiratory problems.

There was also a preponderance of treatment according to Advanced Cardiac Life Support (ACLS) protocol rather than Advanced Trauma Life Support (ATLS) protocol. This often resulted in administration of drugs which were of limited value or even detrimental to the trauma patient.

Performance of invasive procedures taught in the ATLS course and surgical consultation and treatment were often delayed as a result. This was particularly true in cases of cardiac arrest. While the decision to resuscitate patients with traumatic cardiac arrest was, in and of itself, not judged inappropriate care, the use of ACLS rather than ATLS principles was. It was noted that many prolonged efforts at resuscitation of blunt trauma patients in cardiac arrest represented an inappropriate use of resources. This was identified by the panel as a problem requiring rectification. This was also noted to be true in the prehospital phase, with a number of patients in traumatic cardiac arrest receiving aeromedical resources. These findings raise the issue of cost effective utilization of limited resources and strategies to accomplish this goal.

The errors or omissions in those cases listed as having inappropriate care were similar to those in previous studies and revolved around: inadequate airway control, failure to recognize and manage chest trauma, inadequate volume replacement coupled with poor hemorrhage control and timely surgical intervention. Errors or omissions were noted in all phases of hospital care including the emergency department, surgery and intensive care units. Clearly the development of an organized trauma care system is essential to overcoming these problems through appropriate staffing, initial and ongoing training, and the adoption of protocols which reflect current standards of care for the treatment of trauma patients.

Recommendations and Suggested Questions for Future Research

Based upon our experiences in this project, the authors would make the following recommendations:

- Additional studies of this nature should be conducted in other rural environments to validate these findings, to trend results, and to increase the overall sample size.
- Subsequent studies should explore an additional research question, that being, "Do the treatments and interventions provided to trauma patients (particularly cardiac arrest resulting from trauma) represent an appropriate utilization of resources?"
- Subsequent studies should be fully funded, with realistic time lines and without artificial constraints on geographic area or sample sizes, to ensure the smooth and timely completion of the research and reporting and to avoid sample bias. Funding agencies should recognize that the scope and duration of rural mortality studies will vary dramatically from those reported in urban studies due to the complexity of data retrieval from multiple sources and agencies which are unfamiliar with such processes.
- Review panels should be multi-disciplinary including prehospital providers and nursing staff as well as physicians.
- Specific orientation and training using previously determined cases should be provided to review panel members.
- Non-preventability does not excuse inappropriate or sub-standard care. Future studies should examine the incidence, nature and phase of occurrence of inappropriate care so that solutions can be formulated.

- Future studies should catalogue previously identified factors which potentially affect reliability of preventability judgments for the study population and any sub-populations. The degree of panel judgment concordance with the more objective classification criteria suggested by Shackford, et al and the American College of Surgeons should also be noted. This will promote standardization of preventable death study reports, better characterize study populations and study reliability.

- Education of both prehospital and hospital providers in the basic principles of trauma management, with particular emphasis on airway and respiratory problems, would address the majority of problems identified in this study.

- Funding should be identified to facilitate the retrospective study of the remaining areas of Montana which were not included in this study. This will provide a global picture of the current standard of trauma care throughout the entire state. It will further elucidate the differences in rates of preventable death and inappropriate care between the two study areas and would serve as a baseline for the development of a comprehensive statewide trauma system.

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Glossary of Acronyms and Terms

ACLS - Advanced Cardiac Life Support. A continuing education program for physicians, nurses and prehospital personnel designed to improve the outcome of patients suffering sudden cardiac death. Developed and sponsored by the American Heart Association.

ACSCOT - American College of Surgeons: Committee on Trauma.

AIS-85 - Abbreviated Injury Scale. An anatomical injury scoring system which classifies individual injuries by body region. Developed and sponsored by the Association for the Advancement of Automotive Medicine. AIS-90 is now available but has not been validated.

ATLS - Advanced Trauma Life Support. A continuing education program designed for physicians and nurses designed to improve the care and outcome of trauma patients. Developed and sponsored by the American College of Surgeons.

CITF or CIT Foundation - Critical Illness and Trauma Foundation, Inc.

CNS - Central Nervous System. The brain and spinal cord.

DHES - Montana Department of Health and Environmental Sciences.

ED - Emergency Department.

EMS - Emergency Medical Services. A system designed to care for acutely injured or ill patients. Includes both prehospital and hospital care. Trauma Care Systems are one component of EMS.

ICD-9 E - A numerical external cause of injury codification system in use throughout the U.S.

ISS - Injury Severity Score. A scale of 1-75 which represents the seriousness of injuries, calculated by using the AIS for the three most severely injured body regions.

PHTLS - Prehospital Trauma Life Support. A continuing education program for prehospital personnel designed to improve the quality of care and outcome of trauma patients. Similar in nature to ATLS. Developed and sponsored by the National Association of Emergency Medical Technicians.

MWFMC - Montana/Wyoming Foundation for Medical Care. The peer review organization serving Montana.

P_s - Probability of Survival. The end calculation of the TRISS methodology which serves as a predictor of the survivability of injuries. Range from 0.0 - 1.0.

RTS - Revised Trauma Score. A field scoring system which incorporates elements of neurological response, systolic blood pressure and respiratory rate.

Trauma Care System - An organized and integrated system of care for trauma patients. More highly specialized than a general EMS system, resulting in far better outcomes for trauma patients. Includes components from prevention through rehabilitation.

Trauma Register - A computer based program into which data on trauma patients are entered. Provides reports which are useful for quality improvement, evaluation and research.

TRISS - A statistical methodology in which the Revised Trauma Score, Injury Severity Score, patient's age and blunt vs. penetrating trauma are incorporated to calculate the statistical survival probability (P_s).