1998 Rural Preventable Mortality Study

With a comparison to the 1990 Rural Preventable Mortality Study

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Table of Contents

Table of Tables

Executive Summary

Objective

To compare the preventable death rate, as well as nature and degree of inappropriate trauma care, in a rural state prior to and after efforts to initiate a voluntary trauma system.

Methods

Deaths attributed to mechanical trauma occurring in Montana between January 1, 1998 and December 31, 1998 were retrospectively reviewed by a multidisciplinary panel of physicians and non-physicians representing the hospital and prehospital phases of care. Deaths were judged frankly preventable, possibly preventable and non-preventable. Care rendered in all categories was evaluated for appropriateness according to nationally accepted guidelines. Results were then compared to an identical study conducted prior to efforts to initiate a voluntary trauma system. Measures to insure comparability of the two studies were taken.

Results

347 (49%) of all trauma related deaths during the study period met inclusion criteria for review. The overall preventable death rate (PDR) was 8%. In those patients that died after being treated at a hospital, the PDR was 15%. The overall rate of inappropriate care was 36% with 22% prehospital and 54% in hospital. The majority of inappropriate care in all phases of care revolved around airway management and chest injury. The emergency department was the phase of care in which the majority of deficiencies were noted.

In comparison to the results of the earlier study, PDR decreased (8% vs. 13%; $p = .02$). The rate of inappropriate care also decreased for the prehospital and emergency department phases of care (37% vs. 22% $p < .01$; and 68% vs. 40%, $p = .02$). The inappropriate care rate in the post ED phase of care remained similar. Population characteristics influencing inter panel reliability were similar for the two groups compared. Inter-panel reliability was good. ($\kappa = .80$)

Conclusion

Efforts to initiate a voluntary trauma system in a rural state have had a positive affect on PDR and inappropriate care. However, rates of preventable death have not yet reached those attained in mandated, funded, and mature rural trauma systems. This study suggests the adoption of mandated policies and appropriate levels of resource allocations may be the most effective strategy to move the Montana trauma system expediently toward desired outcomes.

Introduction

Injuries are the leading cause of death for ages 1- 44 years in Montana. There were 702 injury deaths in Montana for 1998. Montana's [1] 1998 injury death rate was 74/100,000, considerably higher than the national rate of 56/100,000. For Montana's [1] American Indian population the injury death rate was twice that of the general population at 140/100,000, with the national rate being 80/100,000. For Montanans $\leq$ 19 years of age the injury death rate was 34/100,000 compared to the national rate of 24/100,000. [1]

Prior to the 1990 Rural Preventable Mortality Study (RPMS) that serves as the basis for comparison in the current replication study, these figures were not cause for alarm in either the general population or among the medical community. It was widely assumed that people died from injury in Montana because their injuries occurred in remote locations. It was also generally held that the rate of death was further influenced by the lifestyles and occupations of the rural population. Little credence was placed in the hypothesis that the increased death rate was attributable to deficiencies in the medical care system.

The results of the 1990 Montana RPMS revealed that the total preventable death rate for the state was 13%. For deaths that occurred in the hospital, the preventable death rate was 27%. The rate of inappropriate care for those patients dying in the hospital was 68%. The findings of the 1990 Montana study did not differ from those previously reported in other (both urban and rural) areas without an organized trauma care system. However, the findings did supply the crucial information to trauma care leaders in supporting their request for assistance to the 1993 legislature. Although the legislature enacted a state trauma system statue, no general funds were appropriated. Therefore, the framework for a voluntary trauma system was established. This replication of the 1990 Montana RPMS study will serve to assess the impact of Montana's Voluntary Trauma Care System.

Project Outline

Goal

Organize and conduct a Rural Preventable Mortality Study in Montana.

Objectives

- 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 and compare the results with the 1990 RPMS.

- Identity EMS/Trauma care system problems in Montana that will be useful on supporting regional and state level trauma system policy changes including prehospital, hospital and inter-hospital transport.

Work Plan

Task 1: Replicate the 1990 RPMS study. Identify a detailed methodology for research process; identify problems anticipated in data collection, review and analysis. State proposed methods to resolve said problems.

Task 2: Develop a computer database for data entry, and analysis of study cases.

Task 3: Implement data collection process. Prepare records on each decedent to be included in the study by gathering such records from all available sources; removing all identifying information concerning the patient, caregivers, agencies and institutions.

Task 4: Conclude data collection. Copy and transmit records to expert panel members in a secure fashion.

Task 5: Complete the case review process. Convene an expert panel; provide all members with a formal orientation to the study. Develop and provide an inter-panel reliability testing process that validates findings between the new panel and the 1990 study panel. Convene the panel to review data in a manner comparable to the 1990 study.

Task 6: Complete data analysis and statistical testing.

Task 7: Provide a report of the Montana Rural Preventable Mortality study findings by:

- Providing a draft report to the Montana Trauma Care Committee and the Department for review and comment; and by
- Providing a final report acceptable to the Montana Trauma Care Committee and the Department.

Project Methods

Institutional Review Board Approval

The project methods and procedures were outlined in a formal application to the Human Subjects Review Committee of Montana State University. The project was determined to be exempt from Human Subject Concerns due to its retrospective nature, archival method study design, blinding of record procedures, data safeguards and aggregate reporting methods.

Case Review Administrative Procedures and Tasks

Initial case identification was accomplished by death certificate review. Montana law requires that death certificates be filed with the Bureau of Records and Statistics within the Montana Department of Public Health and Human Services. The death certificates were screened by county code. Those deaths, which occurred within the borders of Montana and were categorized within the ICD-9-E code range of 800-999, were copied and forwarded to the CIT Foundation for possible inclusion in the study. In addition to the primary cause of death noted on the certificate, all cases in which a trauma diagnosis was noted as a secondary or contributing cause were also forwarded and scrutinized for appropriateness of inclusion.

Types of Deaths

The following deaths by ICD-9 E-codes as determined from death certificate data were initially included in the study.

E-Code	Description
800-807	Railway incidents
810-819	Motor vehicle traffic incidents
820-825	Motor vehicle non traffic incidents
826-829	Other road vehicle incidents
830-838	Water transport incidents
840-844	Air transport incidents
846-849	Vehicle incident, not elsewhere classifiable
870-879	Misadventures to patients during surgical or medical care (only where initial injury occurs as a result of trauma)
880-888	Unintentional falls
913-915	Injuries caused by mechanical suffocation and foreign bodies
916-923	Other incidents
955-959	Suicide and self-inflicted injury (excluding suicides by mechanical means not surviving to medical care; and suicide by corrosive or caustic substance, poisoning, hanging or strangulation and drowning)
960-969	Homicide and injury purposely inflicted by other persons (excluding assault by corrosive or caustic substance, poisoning, hanging or strangulation and drowning)
970-976	Legal intervention (excluding legal intervention by gas)
985-989	Injury undetermined whether unintentionally or purposely inflicted

Once received by the CIT Foundation, each case was entered into the database and given a unique case identifier. Information provided in the death certificate dictated the need for further information and the agencies from which to solicit that information. For example, if the death certificate reported that the location of death had been a hospital, then a request for the chart was made to that hospital. Similarly, if performance of an autopsy was noted on the death certificate, the State Medical Examiner was contacted. If the death was reported in a location other than a hospital, staff used knowledge of EMS response patterns to determine which EMS service was likely to have responded and requested the information. Lastly, the cause of death involved a motor vehicle or occurred on a highway, the Division of Highway Traffic Safety was contacted to provide Highway Patrol Investigative Summaries and other relevant information.

The 1990 RPMS indicated that certain deficiencies in data sources and availability of records from the prehospital agencies and hospitals were to be expected. Numerous follow-up requests were often necessary. In some cases, the process of receiving the prehospital and hospital information took more than one year from the initiation of the request to the receipt of the record. The range of hospital size for those hospitals that ultimately provided data was from 6 to 200+ beds. The level of detail and completeness of information recorded in the chart varied significantly (not necessarily in relation to the size of the facility).

Montana does not mandate a standardized EMS run report and statute requires only a minimum set of data. Therefore, the quality of the EMS reports varied from highly detailed to those containing no information. In those instances where EMS records were not included with the hospital chart, every attempt was made to follow-up with the probable responding agencies. These agencies, in the majority of the cases, were willing to share copies of their patient records.

Acquiring coroner records from some counties proved to be a significant challenge. The majority of coroner's reports had been sent to the State Medical Examiner's office. This provided an efficient portal of access to this information. However, several counties lack the resources and time to follow this submission procedure. In those cases the coroner's reports were often unobtainable, in spite of multiple attempts.

The review panel was comprised of 11 medical professionals from the state of Montana with the exception of one of the principal investigators, who practices outside the state. Every effort was made to have a balanced representation from the three regional trauma care committees (RTAC). Despite multiple secure efforts to emergency physician participation, no emergency physicians were represented. This absence of emergency medicine representation is a variance from the previous study. Ultimately the 1998 study was completed with the following case review panel composition:

5 Trauma Surgeons

1 Forensic Pathologist

3 Registered Nurses, (a trauma coordinator, an ED nurse and a flight nurse).

2 EMT's, (one ALS and one BLS)

The absence of neurosurgical and orthopaedic representation on the panel was not a significant deficiency. Only one case was sent outside of the panel for neurosurgical review and no cases necessitated a specific orthopaedic consult.

Case Review Process

Abstracts of each case, stripped of patient and provider identifiers, were prepared by CIT staff for distribution to the case review panel. For each case, two panel members and the co-principal investigators were provided with a complete record to review. One of the two panel members was designated as the primary reviewer. The primary reviewer presented each case to the entire panel with added comments provided by the secondary reviewer. Assurances were made that primary and secondary reviewers did not receive cases from their own area. The co-principal investigators served as arbiters' panel chairpersons. Consensus majority rule was the basis for judgments on preventability and inappropriate care as well as other issues.

Study Population

The final study population included all deaths from mechanical trauma occurring January 1, 1998 – December 31, 1998, so long as sufficient data existed from any singular or collective source(s) determination of preventability. Exclusions were made for: non-mechanical trauma (ICD9-E 808-809, 845, 890-912, 924-954, 977-978, 990-999), insufficient data, and cases of suicide that did not survive to medical care. Deaths occurring prior to, or without, EMS system contact were judged "non-preventable with no care;" however, these cases were examined for potential problems in system access.

Major Data Sources and Elements

Death Certificate: Including patient identifier (later stripped), socio-demographics, times and location of death, coroner/autopsy involvement, primary/contributory causes of death and manner of death.

Ambulance Trip Report: Including prehospital times, protective devices employed, mechanism of injury, vital signs, assessment findings, treatments rendered, delays encountered and patient destination.

Hospital Medical Record: Including mode and time of arrival, emergency department assessment findings, vital signs, ED treatments rendered, duration of stay in ED, surgical consultation, transfer or disposition information, surgical intervention, complications, ICU stay, ICU complications, disposition or death information and discharge diagnoses.

Autopsy Transcript: Including co-morbid factors, quantification of injuries, detailed description of injuries, factors identified which contributed to death, toxicology and blood alcohol levels.

Investigative Report: Including a description of events leading up to incident, description of event, type of vehicle, weapon or other mechanism of injury and where patient was pronounced dead. This information was ascertained from uniform MVC fatality reports, coroners' reports and law enforcement agency investigative summaries.

Data Collection Period

Data were collected for eighteen months commencing June 1, 1999. Follow-up data collection was conducted on select cases if the panel determined that key information was absent during the review process.

Data Entry/Retrieval Process

CIT staff used Microsoft 2000 Excel, and Access for data entry and record tracking. Statistical analyses were performed in SPSS 10. Data were abstracted from each chart using a standardized checklist before computer entry. As an integrity check, a separate staff member verified all coding and data entry.

Preventability Criteria

Preventability determination was based on the following criteria:

Non-Preventable

1. Anatomic injuries considered non-survivable under optimum care (recognized peer review standards utilized).
2. Physiologic state of patient at the time of arrival of first responder may be considered, but non-critical to judgment.
3. Appropriate management using ATLS/ACLS/PHTLS guidelines (suspect care handled as error).
4. Patient had co-morbid factors which were major contributors causing death.

Potentially Preventable

1. Anatomic injuries very severe but survivable under optimum care.
2. Patient generally considered unstable and responds minimally to treatment.
3. Generally appropriate ATLS/ACLS/PHTLS care, suspect care directly or indirectly implicated in patient demise.

Preventable

1. Anatomic injuries considered survivable.
2. Patient generally stable, if unstable patient becomes stable with treatment.
3. Evaluation and management suspect in any way.

Additional Criteria

The following criteria, representative of American College of Surgeons audit filters for quality of care, were used in conjunction with those listed above to indicate cases requiring closer scrutiny for preventability and to further determine appropriateness of care.

- Patient pronounced dead at scene
- Prehospital on scene time: ≥ 20 minutes – American College of Surgeons Committee on Trauma, Audit Filter #2 (ACSCOT 2)
- Prehospital transport time: ≥ 20 minutes
- Total prehospital time: ≥ 30 minutes
- Patient in Emergency Department (ED): 2 hours (ACSCOT 3)
- Patient died in ED
- Patient seen by initial physician after 15 minutes
- Patient experience unplanned return to operating room (ACSCOT 8)
- Patient died within 24 hours of admission
- Patient in 1st hospital ≥ 90 minutes before transfer
- No Trauma Score documented except in intubated patient (ACSCOT 11)

Criteria for Inappropriate Care and Phase Responsible

A determination of the appropriateness of care rendered was made irrespective of the preventability determination, i.e. the care rendered in cases judged non-preventable was evaluated for compliance with accepted standards of the ATLS and PHTLS courses as well as local trauma care protocols if such protocols were present. Cases were determined to have received inappropriate care if one or more deficiencies were noted in any phase of care. Many cases were found to have errors occurring in more than one phase of care, however, the phase in which the most egregious deficiency was noted was the phase categorized as responsible for the inappropriate care.

Utilization of Resources and Other Secondary Issues

During the 1990 RPMS, it became evident that there were additional questions beyond preventability and appropriateness of care that needed to be addressed in subsequent studies, including the appropriateness of each response in terms of resource utilization. Panel members were asked to gauge each case for the appropriateness of resource utilization according to the following criteria.

1. Prehospital response or treatment that places the rescuer or other personnel in danger (unnecessary flights, etc.)

2. Care of a patient whose death was judged to have been non-preventable to the detriment of other patients with survivable injuries.

3. Initiation of resuscitation by prehospital personnel in cases of blunt trauma arrests without signs of life.

4. Prolonged (>20 min.) hospital resuscitation of trauma patients arriving at the ED without signs of life.

5. Delays in trauma team activation or arrival.

6. Elaborate or unnecessary diagnostic testing or surgical interventions of trauma patients without signs of life.

Parallel Issues Considered

Behavioral Factors

- Alcohol/drug use
- Utilization of automobile restraint systems
- Utilization of protective devices, e.g. motorcycle helmets

Environmental Factors

- Weather/road conditions
- Road hazards
- Remote locations (wilderness areas, etc.)

Co-Morbid Factors

- Patient's age
- General physical health

Cultural Considerations

- Language barriers
- Other

Inadequate or Missing Documentation

An additional concern was the frequency with which documentation of care, both prehospital and hospital phases, was inadequate to determine what actually transpired during the course of treatment. Inadequate documentation was defined as either missing records or documentation inadequate for ongoing quality assurance or continuing quality improvement activities at any level.

The panel also examined delays in discovery, delay in EMS response, and excessive scene time in both prehospital and hospital phases.

Project staff, under the direction of the project epidemiologist, conducted statistical analyses of study data. Statistical methods included: frequency distribution, cross tabulation and statistical testing as considered appropriate (significance level was set at 0.05).

Results

There were 7,961 deaths in Montana from all causes during the study period. Seven hundred and two (8%) of these were related to trauma. Three hundred and fifty-five (355) of these trauma-related deaths were excluded from the study, 235 (66%) due to non-mechanical nature of the trauma, 90 (25%) due to death being a result of suicide not surviving to the hospital, and 30 (8%) due to insufficient information being available to determine preventability. Therefore 347, representing 49% of all trauma-related deaths, were reviewed and judged by the panel. Of the 347 study cases, 246 (71%) had no autopsy or an external autopsy only. These cases were included for review because other information, sufficient to determine preventability and appropriateness of care, was available.

Gender distribution was 252 (73%) male and 95 (28%) female. Mean age was 44 with a range from < 1 to 96 years, and a median of 42 years. The racial distribution was 82% Caucasian, 15% American Indian and 3% other.

Table 1: Mechanism of Injury (N=347)

Mechanism	#	%
Motor Vehicle Crash	199	57.3
Fall	47	14.0
Gunshot Wound	28	8.0
Pedestrian Struck	13	3.7
Motorcycle Crash	9	2.5
Agricultural	8	2.3
Aircraft	8	2.3
Stab Wounds	5	1.4
Industrial	3	0.8
Train	3	0.8
Other	24	7.0
Total	347	100

Corresponding distribution of these ethnic groups in the general population is 93%, 6% and 1% respectively. Three hundred and eight (89%) of injuries were unintentional, 39 (11%) were intentional. Of the intentional injuries 25 (64%) were homicides and 14 (36%) suicides (excludes suicides not surviving to a hospital and suicide by non-mechanical means). Three hundred and fourteen (90%) of all fatalities resulted from blunt injuries, and 33 (10%) from penetrating. Mechanisms of injury are illustrated in Table 1.

Alcohol

Information was obtained on alcohol use for 251, (72%) of all cases. Of these, 113 (45%) tested positive for alcohol use, 84 (35%) of whom were legally intoxicated (>.10gm/100 DL) according to Montana statutes. Positive blood alcohol levels were noted in 68% of those dying as a result of motor vehicle crashes. 77% of the motor vehicle drivers or pedestrians struck were legally intoxicated.

Restraints

For motor vehicle occupant fatalities where information on restraint use was available (197 of 199 cases), 54 occupants were restrained (27%) and 143 (73%) were unrestrained. For all motor vehicle crashes reviewed, 85 (43%) involved single vehicle rollovers and sixty-three (74%) of those decedents were reportedly ejected from the vehicle.

Preventable Death Determination Results

Of the 347 cases studied, 2 (1%) were judged frankly preventable and 23 (7%) potentially preventable, yielding an overall preventability rate of 8% see Table 2. The remaining 322 (93%) were judged non-preventable.

Table 2: Preventability for All Cases (N = 347)

Preventability	#	%
Frankly Preventable	2	1
Potentially Preventable	23	7
Total Preventable Deaths	**25**	**8**
Non-Preventable Deaths	322	93

Table 3 presents the cause of death for preventable death cases.

Table 3: Cause of Death for Preventable Cases (n = 25)

Cause of Death	#	%
CNS	3	12
Airway	8	32
Hemorrhage	7	28
Sepsis	3	12
Indeterminate	4	16

Table 4: Preventability for Deaths – Prehospital (n = 191)

Preventability	#	%
Frankly Preventable	1	<1
Potentially Preventable	1	<1
Total Preventable Deaths	**2**	**1**
Non-Preventable Deaths	189	99

One frankly preventable and one potentially preventable death were attributed to the prehospital phase of care (Table 4).

Considering only hospital deaths (n = 156), the preventable mortality (FP + PP) rate was 15% (Table 5).

Table 5: Preventability of Deaths – Hospital (n = 156*)

Preventability	**#**	**%**
Frankly Preventable	1	1
Potentially Preventable	22	14
Total Preventable Deaths	**23**	**15**
Non-Preventable Deaths	133	85

* Includes 3 cases transported to the hospital by private vehicle

The rates of inappropriate care rendered to all patients studied was 36% (125/347) and 54% for the hospital deaths (84/156). Table 6 depicts the number and percentage of incidents of inappropriate care by cause of death.

Table 6: Distribution of Inappropriate Care by Causes of Death

Cause of Death	**Total Deaths**	**Inappropriate Care**	
	#	#	%
CNS	104	52	50
Airway	17	11	65
Hemorrhage	39	20	51
Sepsis	4	4	100
Indeterminate	183	38	21
Total	347	125	

Inappropriate care was noted in 125 patients. Where inappropriate care was noted, the ED phase of care was implicated as responsible for the most serious deficiencies in 62 of the 125 cases (50%). The prehospital phase was implicated in 41 or the 125 cases (33%) and the post ED phase in 22 of the 125 (18%). Deficiencies in care relating to the airway and management of chest injury were the most prevalent for the entire sample, and occurred most frequently in the ED phase. Deficiencies related to fluid resuscitation were also seen more frequently in the ED phase. The prehospital phase was most likely to demonstrate deficiencies in c-spine precautions (Table 7).

Table 7: Nature of Inappropriate Care by Phase of Care (n = 125)

Deficiency	**Prehospital (n = 41)**		**ED (n = 62)**		**Post ED (n = 22)**		**Total (n = 125)**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Airway Control	13	10	21	17	7	6	41	33
Hemorrhage Control	1	1	0	0	2	2	3	2
Management of Chest	3	2	9	7	1	1	13	10
Fluid Resuscitation	0	0	22	18	4	3	26	21
C-Spine	11	9	3	2	0	0	14	11
Other	13	10	7	6	8	6	28	23
Total	41	32	62	50	22	18	125	100

When all deficiencies for each case are considered, 244 cumulative errors of care were identified among the 125 patients receiving inappropriate care: 57 (23%) attributed to the prehospital phase; 141 (58%) to the ED phase and 46 (19%) to the post ED phase.

Table 8 illustrates the distribution of inappropriate care by error type and phase of care.

Table 8: Distribution of inappropriate care by phase of care (N=347)

Phase of Care (Patient Contacts)*	Inappropriate Care Related to	Number of Occurrences	Percentage of Patient Contacts
Prehospital (n =191)	Airway management	29	15.1
	Bleeding control	1	0.5
	C-spine immobilization	20	10.4
	Fluid resuscitation	0	0.0
	Fracture stabilization	0	0.0
	PASG use	0	0.0
	Other	7	3.6
Total Prehospital		57	
Emergency Dept (n =156)	Airway management	27	17.3
	Chest injury management	16	10.2
	Fluid resuscitation	22	14.1
	Intravenous placement	6	4.0
	PASG use	0	0.0
	Intra-abdominal evaluation	8	5.0
	Use of vasoactive drugs	15	10.0
	Injury recognition	17	10.8
	Radiographic imaging	13	8.3
	Other	17	10.8
Total ED		141	
Post ED (n = 77)	Inappropriate operation	8	25.9
	Fluid management	6	7.7
	Head injury management	8	10.3
	Management of re-bleeding	3	1.9
	Ventilator management	9	11.6
	Other	12	11.6
Total Post ED		46	
Total All Phases		244	

Since the number of patients treated varied in each phase of care due to deaths in the previous phase, adjusted rates of inappropriate care were calculated for each phase based on the number of cases treated in that phase. Results are noted in Table 9. Once again the ED phase demonstrated the highest percentage of inappropriate care.

Table 9: Rate of Inappropriate Care by Phase Responsible

Phase	Total Cases Treated	Adjusted % of Inappropriate Care
Prehospital	191	22
ED	156	40
Post ED	77	29

Associated system access delays were noted as follows: 51 cases were judged as having either a delay to discovery or a delay in EMS response. This represents 15% of all cases reviewed. Nine (2%) of all cases were judged to have had excessive scene times. Of the 191 cases where death occurred in the prehospital phase, 67 received no EMS treatment. Only 62 of the remaining 124 cases (50%) had documentation of treatment available for review. The absence of documentation for review was attributable to non-existence (run sheet not completed) or refusal of the responsible agency to submit existing documentation for review, or both.

Comparison With the 1990 RPMS

A comparative analysis of the two studies was performed. Chi Square tests of expected frequencies were performed for the following: total deaths for Montana regardless of cause, trauma deaths, cases excluded, victims of suicide surviving to hospital, total number of trauma deaths reviewed, number of deaths due to unintentional and intentional causes, mechanism of injury, preventable deaths, death occurring in the hospital phase, rate of inappropriate care for the total cases reviewed, and inappropriate care rendered in each phase of care.

Changes between the 1990 and 1998 RPMS

Changes in the demographic variables studied in 1990[4] and 1998 are outlined in Table 10. While the total number of deaths occurring Montana has increased, trauma related deaths did not show a corresponding increase. There were no statistically significant changes between the two study periods with regards to mechanism of injury, with the exception of the number of intentional injuries reviewed.

Table 10: Case Mix Comparison – 1990-1998

	1990	1998	P value
Total Deaths	6769	7961	p. <.01
Trauma Deaths	629	702	p. = .83
Excluded Cases	305	355	p. = .35
Trauma Deaths Reviewed	324	347	p. = .69
Unintentional Deaths	269	308	p. = .30
Intentional Deaths	55	39	p. = .04

Table 11 below presents the comparison of preventable trauma deaths without regard to the phases of care where the patient was treated. The denominators for this table are the total samples reviewed in 1990 (N=324) and 1998 (N=347). A decrease in the preventable death rate is noted in the more recent study period (p = .02).

Table 11: Preventable Deaths for All Cases Reviewed 1990 and 1998

Preventability	1990 Deaths		1998 Deaths	
	#	%	#	%
Frankly Preventable	5	2	2	1
Potentially Preventable	36	11	23	7
Total Preventable Deaths	**41**	**13**	**25**†	**8**
Non-Preventable Deaths	283	87	322	93
Total Cases	324		347	
				† Significance p = .02

Significant decreases were also noted in preventable deaths occurring in the hospital. In 1990 27% of all hospital deaths were preventable, in 1998 that figure decreased to 15% (p. = .04). Non-preventable deaths remained unchanged between the two study periods. Table 12 depicts the number and percentages for hospital preventable and non-preventable deaths between the two study periods.

Table 12: Preventability for Deaths Occurring in the Hospital

Preventability	1990 Study		1998 Study	
	#	%	#	%
Frankly Preventable	5	3	1	1
Potentially Preventable	34	23	22	14
Total Preventable Deaths	**39**	**27**	**23**†	**15**
Non-Preventable Deaths	107	73	133	85
Total Cases	146		156	
				† Significance p = .04

When appropriateness of care was reviewed, without regard to survivability of injuries sustained, a significant decrease of inappropriate care was found in both the emergency department and prehospital phase of care, (p < .01) and (p = .02), respectively. Deficiencies in the post ED phase of care remained similar between the studies. Table 13, compares adjusted rates of inappropriate care between the two study periods.

Table 13: Adjusted Rates of Inappropriate Care by Phase of Care

Phase	1990			1998		
	Patient Contacts	Inappropriate Care		Patient Contacts	Inappropriate care	
		#	%		#	%
Prehospital *	131	49	37	191	41†	22
ED	120	81	68	156	62‡	40
Post ED	57	28	49	77	22	29
						† Significance p = .02, ‡Significance p < .01

*Excludes prehospital contacts without care rendered (e.g. pronounced dead at scene by coroner.)

In comparing the nature of inappropriate care between the two study periods, the prevalence of respiratory management (airway and chest injuries) errors are similar. However, in the 1990 a preponderance of this type of deficiency was seen in ED care, while in the 1998 study these were prevalent in both the prehospital and ED phases.

Table 14: Inappropriate Care – adjusted and unadjusted rates 1990 and 1998

Phase of Care (Patient Contacts)*	Inappropriate Care Related to	Occurrences		% Patient Contacts		% Total Patients	
						N= 324	N=347
		1990	**1998**	**1990**	**1998**	**1990**	**1998**
Prehospital	Airway management	22	29	16.8	15.1	6.8	8.0
(n = 131) 1990	Bleeding control	0	1	0.0	.5	0.0	0.2
(n = 191) 1998	C-spine immobilization	10	20	7.6	10.4	3.1	5.7
	Fluid resuscitation	4	0	3.1	0.0	1.2	0.0
	Fracture stabilization	2	0	1.5	0.0	0.6	0.0
	PASG use	7	0	5.3	0.0	2.2	0.0
	Other	9	7	6.9	3.6	2.8	2.0
Total PH		54	57				
Emer. Dept.	Airway management	18	27	15.0	17.6	5.6	7.7
(n = 120) 1990	Chest injury management	26	16	21.7	10.4	8.0	4.6
(n = 153) 1998	Fluid resuscitation	18	22	15.0	14.3	5.6	6.3
	Intravenous placement	8	6	6.7	3.9	2.5	1.7
	PASG use	3	0	2.5	0.0	0.9	0.0
	Intra-abdominal injury eval.	11	8	9.2	5.2	3.4	2.3
	Use of vasoactive drugs	15	15	12.5	9.8	4.6	4.3
	Injury recognition	10	17	8.3	11.1	3.1	4.8
	Radiographic imaging	10	13	8.3	8.4	3.1	3.7
	Other	9	17	7.5	11.1	2.8	4.8
Total ED		*128	141				
Post ED	Inappropriate operation	6	8	10.5	10.3	1.9	2.3
(n = 57) 1990	Fluid management	5	6	8.8	7.7	1.5	1.7
(n = 77) 1998	Head injury management	7	8	12.3	10.3	2.2	2.3
	Management of infection	3	**0.0	5.3	0.0	0.9	0.0
	Management of re-bleeding	1	3	1.8	1.9	0.3	0.8
	Ventilator management	3	9	5.3	11.6	0.9	2.5
	Other	10	12	17.5	15.5	3.1	3.4
Total Post ED		35	46				
Total All Phases		217	244			66.9	70.3

*Some patients were noted to have multiple errors in a single phase of care.
**While there were 4 deaths in this sample that died of sepsis, the panel attributed errors in care to the underlying etiology rather than sepsis per se.

In comparing the use of resources between the study periods, the most apparent differences were found in the categories of transportation resources and futile resuscitation efforts. (Table 15)

Table 15: Inappropriate Utilization of Resources

Study Period	1990	1998
Resource	**Percent**	**Percent**
Prehospital Resources	47	10
Transportation Resources	16	19
Futile Resuscitation Effort	5	50
Diagnostic Resources	11	7
Surgical Resources	0	3
Other	41	11
Total	100	100

Trauma System Issues

The purpose of 1998 RPMS study was to document changes occurring since the institution of a voluntary trauma system in the state. Added to the review for the 1998 study was a category titled "Trauma System Issues". This required the panel to identify and judge the following factors as they affect the care of a patient, regardless of preventability: activation of a full resuscitation team, pre-notification by prehospital providers, timeliness of team arrival, destination of transfer, timeliness of transfer, delay in discovery of patient, and cultural considerations. Other issues considered included: EMS at the scene but no report generated, inability of prehospital personnel to pronounce patient dead in the field, and inaccessible or missing records. Table 16 summarizes distribution of identified trauma system issues.

Table 16: Trauma System Issues (N = 347)

Death Was / Trauma System Issue	Frankly/ Possibly Preventable n = 25	Non-Preven-table No Care n = 156	Non-Preven-table Care Appropriate n = 66	Non-Preven-table Care Inappropriate n = 100	Total N = 347	
	#	#	#	#	#	%
Activation of full team	4	0	1	8	13	4
No pre-notification		1	1	1	3	1
Arrival of team	1	0	1	4	6	2
Destination of transfer	0	0	0	3	3	1
Timeliness of transfer	2	0	1	9	12	3
Delay in discovery	1	39	1	4	45	13
Cultural considerations	2	4	0	0	6	2
PH transport of deceased	1	0	0	3	4	1
Futile prehospital care	0	0	0	2	2	1
Denied/Missing reports	0	3	6	2	11	3
Lack of PH documentation	1	55	0	0	56	16
Other	3	1	8	15	27	8
Total	15	103	19	51	188	

Discussion

The rate of preventable trauma deaths has declined significantly since 1990. This suggests that institution of a voluntary trauma system in Montana is having a positive effect on trauma care and outcome. However, the overall preventable death rate of 8% remains higher than the reported 4.5% achieved in a fully funded rural trauma system in Oregon.[5, 6, 7] This comparison would seem valid as both states have similar patterns of trauma and medical resource characteristics.

Although there has been a notable decline in errors occurring in the emergency department phase of care since 1990, 50% of the patients receiving care in the ED still had deficiencies associated with that care. When emergency department and post emergency department phases of care are considered, inappropriate care increases to 54%. As in 1990, the majority of sub optimal care relates airway and chest injury management and fluid resuscitation. These reflect a disturbing and persistent inability to inculcate the basic tenets of ATLS – airway, breathing and circulation, into the practices of primary caretakers of trauma patients.

The prehospital phase of care, also exhibited improvement in the amount of inappropriate care rendered in comparison to 1990 (22% vs. 37%). However, this degree of inappropriate care was implicated in 2 of the 25 (8%) preventable death noted in this study. Errors in this phase of care were also fundamental in nature and again included primarily airway management. Deficiency in C-spine protection ranked second. Errors occurred at similar rates for both basic and advanced life support services.

It would seem more effective methods of conveying and maintaining knowledge and practice of basic principles must be sought in ATLS, PATLS, medical school, residency and, continuing education and in the EMT curricula. Current learning tools do not seem effective.

There were a number of instances of inappropriate resource allocation. Among these, the most common was futile resuscitation efforts. These were primarily associated with blunt trauma arrests occurring in the prehospital phase of care. There is voluminous evidence showing a survival rate of near zero even under optimum conditions. Additional over-utilization of transportation and other prehospital resources were noted in these patients.

A significant conservation of human, technological, and financial resources could potentially be recognized if policies allowing prehospital providers to not initiate and cease futile resuscitation efforts. These preliminary findings may support the need to conduct a formal cost/efficiency study on prehospital resuscitation of patients suffering traumatic cardiac arrest. Such a study would lend credence and validity to the process of instituting prehospital “Do Not Resuscitate” (DNR) and “Cessation of Resuscitation” standing medical orders (SMO). Such policies if considered would require strict criteria for application and close monitoring as a part of trauma system performance improvement activities. Consideration and implementation of such policies clearly has the potential to benefit the Montana trauma system and the health care system as a whole.

Likewise, futile resuscitation extended into the ED phase of care with the use of precious resources such as OR time and personnel, blood products and diagnostic modalities on patients with no chance of survival. It again seems there is an opportunity to educate primary care providers as to which patients fall into the non-survivable category and what constitutes futility. Guidelines developed and promulgated by trauma system physician leadership would serve to give a sense of "permission" to primary trauma care providers who are often reluctant to "do nothing" . These multiple factors range from legal to philosophical, to cultural to knowledge base and often result in inappropriate care even when it is known that nothing can be done.

A wide variety of trauma system deficiencies were noted. One of the most prevalent was delay in discovery. This reinforces the need for continued activities in the area of injury prevention and automatic crash notification systems.

Reports of EMS being at scene without associated documentation comprise the majority of the trauma system issues and were noted primarily when the panel ruled the death "non-preventable with no care rendered." Absences of written records were found in both BLS and ALS levels of prehospital care. These cases were discovered by the examination of other documentation, i.e. coroner or Montana Highway Patrol reports that revealed an EMS presence at scene. Further investigation often confirmed the EMS response but policies did not apparently require documentation of response unless it resulted in a patient transport. The large number of EMS scene responses without documentation emphasizes a need for policies that assure documentation of care on each and every response. This is crucial not only for quality improvement activities within the trauma system, but as legal protection for prehospital care providers.

In the hospital phase, many deficiencies revolved around the pre-notification, activation or arrival of the full trauma team. This occurred despite the fact that the panel provided a great deal of latitude concerning the composition of the team commensurate with the size and capabilities of the facility. Additionally, delays in initiating or completing a transfer were noted deficiencies. All of these issues again can be addressed by more formal institution of system standards for hospital trauma response and closer monitoring through a funded system performance improvement program.

Conclusion

When measured both by preventable death and inappropriate care rates, trauma care has improved in Montana with the evolutions of the voluntary trauma system. All contributors and participants in the system can share in the credit for such improvement in trauma care in Montana. However, it is clear there are opportunities for improvement. Such opportunities have been recognized in both rural and urban trauma systems where legislated authority, performance standards and funding for performance improvement and other system operation activities are in place.

Rates of inappropriate care, in particular, remain unacceptably high. Errors tend to be very basic and consistent with those targeted by standardized trauma training programs.

Providing additional resources to the voluntary trauma system may result in continued improvements. However, a more formally mandated system, complete with the fiscal resources for development, monitoring, evaluation and improvement may be a more efficient way to accelerate the attainment of desirable trauma system outcomes.

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References

1. Centers for Disease Control and Prevention (CDC), National Center for Injury Prevention and Control. (2001). *Wisqars, Injury Mortality Reports*. http://www.cdc.gov/data/statistics

2. Esposito, J. T., Sanddal, N. D., Hansen, J. D., & Reynolds, S. A. (1995). Analysis of preventable trauma deaths and inappropriate trauma care in a rural state. *Journal of Trauma, 39(5),* 955-962.

3. Borzotta, A. P., Esposito, T. J., Reynolds, S. A., Hansen, J. D., Irwin, L., & Sanddal, N. D. (1998). A statewide trauma system improves rural preventable mortality and quality of care. *Proceedings of the Eastern Association for the Surgery of Trauma, Journal of Trauma, 44(12),* 1998.

4. Hansen, J., Borzotta, A., Reynolds, S., Sanddal, N., Irwin, L., & Esposito, T. (1996). A comparison of preventable trauma mortality rates in rural areas with and without an organized system of trauma care. *Proceedings of the Third World Conference on Injury Prevention and Control, Australia, World Health Organization,* 152.

5. Mullins, R.J., Mann, N.C., Hedges, J.R. Worall, W. & Jurkovich, G.J. (1998). Preferential benefit of implementation of a statewide trauma system in one of two adjacent states. *Journal of Trauma 44(4),* 607-619