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Rural vs. Urban Trauma: Demographic Influences on Autopsy Rates

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Abstract

Background—The autopsy has long been considered the gold standard for quality assurance review. Studies characterizing autopsies have been completed in large urban centers, but there is a paucity of research regarding autopsies at rural trauma centers. This is problematic considering that a majority of preventable trauma deaths occur in rural areas and death rates for unintentional injuries in rural populations are higher than urban populations. Rural trauma centers have differing characteristics warranting further research into the demographic differences between rural and urban trauma patients and the effects on autopsy rates.

Materials and Methods—This is a demographic study of a rural trauma center, University of Iowa Hospitals and Clinics (UIHC), with the goal of identifying characteristics of trauma patients on which autopsy was performed. 496 deaths were identified from the trauma registry between January 2002 and May 2007 (231 of which were autopsied) and demographic data (including age, race, length of hospital stay, etc.) regarding these patients was gathered into a database. Univariate and multivariate linear regression models were used to analyze differences between autopsied and non-autopsied trauma patients. Autopsy rate and basic demographics were also compared to two recent reports from urban trauma centers.

Results—Autopsied patients were younger than non-autopsied patients (mean age 45 years vs. 71 years; $p < 0.0001$) and have a shorter median length of hospital stay (1 day vs. 4 days; $p < 0.0001$). Autopsy rates for patients with blunt trauma were lower than rates for patients with penetrating or burn trauma (42% vs. 67% and 56%; $p = 0.004$). If patients died while on a subspecialty service they were less likely to have an autopsy. When compared to urban centers, this rural trauma center had lower autopsy rates, higher rates of blunt trauma, a higher mean age of deceased patients, and a lower percentage of males.

Conclusions—UIHC, a rural trauma center, has a number of demographic characteristics that make it unique from urban trauma centers: an older population, lower percentage of male trauma patients,

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higher rates of blunt trauma, and lower rates of penetrating trauma. All of these factors influenced the lower rate of autopsies completed at rural trauma centers. Within a rural trauma center those patients less likely to receive autopsy were older patients, those who expired after 48 hours in the hospital, and patients who suffered blunt injuries. The demographics of trauma patients most likely to receive an autopsy tend to correspond with those of an urban trauma population, thus providing a demographic explanation for the variation in autopsy rates among trauma systems.

Introduction

Autopsy after traumatic death serves many purposes: it is part of the medical examiners death investigation, it is part of surgeon and resident educational Morbidity and Mortality Conference (M&M), part of trauma system quality assurance, and can provide closure for grieving family members¹. According to the American College of Surgeons Committee on Trauma (ACS-COT), trauma systems must have processes in place to ensure performance improvement and patient safety. All deaths are to be systematically reviewed². Although the ACS-COT does not require autopsy to maintain verification as a trauma system, the autopsy has long been considered the gold standard for quality assurance review^{3,4,5}.

The optimal rate of autopsy after traumatic death is controversial. It often centers around the need for an accurate forensic autopsy for legal purposes, and identifying all injuries for quality assurance (QA) and education reasons^{6,7,8}. With the advancement in imaging modalities such as computed tomography, ultrasonography, and magnetic resonance imaging (MRI) some practitioners even advocate abandoning the autopsy in favor of a virtual autopsy^{9,10}. However, with these new imaging novelties, the rate of misdiagnoses and false-positive diagnoses has still remained constant, while the percentage of false-negative increased¹¹.

Most reports about autopsy rate after traumatic death have come from urban trauma centers. Autopsy rates range from 60-99 percent in these series. Very few rural trauma centers have reported their autopsy experience. In rural trauma, the mechanisms of injury, the manner of presentation, and the patient demographics are markedly different from trauma centers in urban areas^{12,13}. While the research contributions from the urban centers are valuable and a good starting point, many preventable traumatic deaths happen in rural areas; extrapolating experience from urban to rural centers about autopsy rates and findings might lead to skewed perceptions about the utility of autopsy in the rural group of patients.

Methods

The level one trauma center at University of Iowa Hospitals and Clinics (UIHC) in Iowa City, Iowa admits about 2000 injured patients per year from the eastern half of the state and portions of neighboring states. The catchment area covers approximately 19,200 square miles and 1.8 million people. Over 95% of the ninety-nine counties in the state of Iowa are classified as rural. Iowa City has a population of about 62,000 and is the 6th largest city in the state. The largest city and the capital, Des Moines has a population of about 200,000 people and is about 150 miles away. Every city in the state has a population density of less than 1000 persons per square km. The trauma center at UIHC is one of two level one centers in the state. A state wide trauma system with mandatory participation and transfer arrangements between all hospitals was created over 10 years ago.

In Iowa, the Medical Examiner of the county in which the death occurred (in our case, Johnson County, Iowa) has the authority to order an autopsy if it will assist in his/her death investigation. The county of the requesting Medical Examiner (Johnson County) is billed by the Pathology Department at UIHC. Johnson County then seeks reimbursement from the patient's county of residence. If the patient is from out of state, this request is often denied.

If the Medical Examiner does not need an autopsy to fulfill her/her statutory responsibility of determining the cause and manner of death, then the clinicians may request consent from the family to perform an autopsy. In these instances, the costs incurred by the procedure are absorbed by UIHC. There were no family consent autopsies in this series.

Traumatic deaths were identified from the UIHC trauma registry between January 2002 and May 2007. Registry data was downloaded into a database and was divided into two cohorts: those who had an autopsy and those who did not. Basic t-test and Chi-square tests were performed in SAS 9.1 to identify differences between these cohorts. A forward, stepwise multivariate logistic regression was used to identify characteristics of patients who received autopsies.

Two recent reports on autopsy rate after traumatic death from urban trauma centers were chosen as comparators^{14,15}. Characteristics such as autopsy rate, penetrating injury rate, age, and gender were abstracted and compared by Chi-Square.

Results

There were 10,937 trauma team activations during the study period with an average ISS of 11.1. There were 496 deaths during the study period with an average Injury Severity Score (ISS) of 28.6. Two hundred thirty-one were autopsied for an overall autopsy rate of 46%. Eighty-three percent of the deceased patients died from blunt mechanisms; 45 % of the deceased were female; and the average age was 58 years.

Demographic comparisons between autopsied and non-autopsied patients show many differences. Autopsied patients are younger, more likely male, have a higher rate of penetrating injury, have higher substance abuse rates, are admitted to trauma service (as opposed to subspecialty service like neurosurgery or orthopedics), and die earlier in the hospital course (Table 1).

With multivariate analysis predicting autopsy many of the covariates dropped out. There was a large degree of colinearity - i.e. younger patients were more likely to be male, have penetrating wounds and be intoxicated). The final model contained age, time of death in hospital course, and if they were admitted to the trauma service or a subspecialty service (Table 2).

When compared to recent reports from two urban centers (identified here as Urban 1 and Urban 2), UIHC had a lower autopsy rate, but also had older patients, more females, and more blunt trauma - all characteristics which predict a lower autopsy rate at a rural trauma center in the multivariate model (Table 3).

Discussion

This study indicates that demographics can affect autopsy rates of trauma populations. Compared to the higher autopsy rates recently reported from two trauma centers located in urban areas (97% and 68%), the lower autopsy rate of 46% at a rural trauma center can be attributed to an older population and increased frequency of blunt trauma. Rural trauma centers have very different patient demographics and different rates of autopsy. Questions about the ideal autopsy rate, the utility of autopsy, the accuracy and validity of autopsy after traumatic death are still unresolved.

Analysis of this data base for missed injuries, unexpected findings, complete autopsy rate, and usefulness of autopsy are being performed. Even with these answers the basic questions about the role of autopsy after traumatic death, and thus the demographics and appropriate rate are unresolved.

Autopsy rates have declined in the last fifty years. There are many reasons for this decline, including the non-reimbursed expense of an autopsy, improved pre-mortem diagnoses, and the misplaced fear of litigation stemming from elucidated medical errors¹⁶. Furthermore, with an ageing population, and low rate of penetrating and interpersonal violence, demographics alone suggest that autopsy rates might be lower.

If there are no forensic implications in the death, then one of the motivating factors for performing an autopsy is abrogated. Also when patients die after several days in the hospital, the clinicians have had an opportunity to perform serial exams and review CT scans and other tests, thus reducing the opportunity of unexpected death. When patients die on subspecialty services such as neurosurgery or orthopedics, they by definition are limited to single system issues which the various services felt could best be managed by the sub-specialists; furthermore, when these patients die, the caretakers might not be as attuned to the importance of post mortem when they report the case to the medical examiner.

Despite the overall decline in autopsy rates and the numerous postulated reasons for this decline, the autopsy is still an important part of the teaching mission and quality improvement in a trauma center. Numerous studies, completed across decades and in numerous locales, have found that autopsies do, indeed, elucidate missed injuries^{17,18}. Particularly in a trauma center, the findings in these cases of missed diagnoses have direct relevance for adjusting for injury severity and reducing missed injuries in future patient care at these centers¹⁹. As this study has demonstrated, trauma systems serve unique patient populations with patient demographics and injury profiles that differ significantly from one another. As such, the rates and types of missed injuries are likely to differ between trauma centers, and the autopsy allows for each physician and each trauma system to examine their own performance in order to reinforce successes and address deficiencies in patient care. Thus, despite the many reasons for the decline in autopsy rates and the questions regarding its changing role in medical care, the autopsy remains a crucial component of continuing trauma system development.

Conclusions

In a rural trauma center, demographics of deceased patients are different from those in urban centers, which helps explain differences in autopsy rates. Autopsies remain valuable in trauma centers despite improvements in imaging techniques. The optimal rate of autopsy will be dictated by patient demographics, manners and causes of death, and missed injury rate - these rates will vary depending on patient characteristics each trauma center, necessitating an individualized approach.

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References

1. Oppewal F, Meyboom-de Jong B. Family members' experiences of autopsy. *Fam Pract* Jun;2001 18 (3):304–8. [PubMed: 11356739]
2. Resources for Optimal Care of the Injured Patient. 2006, American College of Surgeons Committee on Trauma. Chicago, IL: 2006. CD 16-1, CD 16-19, CD 16-25
3. Goldman L, Sayson R, Robbins S, Cohn LH, Bettmann M, Weisberg M. The value of autopsy in three medical eras. *N Engl J Med* 1983;308(17)
4. Martin BT, Fallon WF, Palmieri PA, Thomas ER, Breedlove L. Autopsy Data in the Peer Review Process Improves Outcomes Analysis. *Journal of Trauma* 2007;62:69–73. [PubMed: 17215735]
5. Sharma BR, Gupta M, Harish D, Singh Virender Pal. Missed diagnoses in trauma patients vis-à-vis significance of autopsy. *Injury* 2005;36(8):976–983. [PubMed: 16005004]

6. Forsythe RM, Livingston DH, Lavery RF, Mosenthal AC, Hauser CJ. Autopsies in Trauma Do Not Add to Peer Review or Quality Assurance. *Journal of Trauma* 2002;53(2):321–325. [PubMed: 12169941]
7. West JG. An Autopsy Method for Evaluating Trauma Care. *Journal of Trauma* 1981;21:32–34. [PubMed: 7463535]
8. O'Mara MS, Battistella F. Do we still need autopsies? *Current Surgery* 2004;61(2):151–155. [PubMed: 15051254]
9. Dirnhofer R, Jackowski C, Vock P, Potter K, Thali MJ. VIRTOPSY: minimally invasive, imaging-guided virtual autopsy. *Radiographics* Sep-Oct;2006 26(5):1305–33. [PubMed: 16973767]
10. Farkash U, Scope A, Lynn M, Kugel C, Maor R, Abargel A, Eldad A. Preliminary experience with postmortem computed tomography in military penetrating trauma. *J Trauma* Feb;2000 48(2):303–8. [PubMed: 10697091]
11. McPhee SJ. The autopsy: an antidote to misdiagnosis. *Medicine* 1996;76:41–3. [PubMed: 8569469]
12. Rogers FB, Shackford SR, Hoyt DB, Camp L, Osler TM, Mackersie RC, Davis JW. Trauma deaths in a mature urban vs rural trauma system. A comparison.: *Arch Surg* Apr;1997 132(4):376–81.
13. Rinker CF, Sabo RR. Operative management of rural trauma over a 10-year period. *Am J Surg* Dec; 1989 158(6):548–51. [PubMed: 2589587]
14. Sauaia A, Moore FA, Moore EE, Moser KS, Kathe S, Brennan R, Read RA, Pons PT. Epidemiology of Trauma Deaths: A Reassessment. *Journal of Trauma* 1995;38(2):185–193. [PubMed: 7869433]
15. Ong AW, Cohn SM, Cohn KA, Jaramillo DH, Parbhu R, McKenney MG, Barquist ES, Bell MD. Unexpected findings in trauma patients dying in the intensive care unit: results of 153 consecutive autopsies. *Journal of the American College of Surgeons* 2002;194(4):401–406. [PubMed: 11949744]
16. Shojania KG, Burton EC, McDonald KM, Goldman L. Overestimation of clinical diagnostic performance caused by low necropsy rates. *Qual. Saf. Health Care* 2005;14:408–413. [PubMed: 16326784]
17. Shojania KG, Burton EC, McDonald KM, Goldman L. Changes in Rates of Autopsy- Detected Diagnostic Errors Over Time. *JAMA* 2003;289:2849–2856. [PubMed: 12783916]
18. Stothert JC, Gbaanador GBM, Herndon DN. The Role of Autopsy in Death Resulting from Trauma. *Journal of Trauma* 1990;30(8):1021–1026. [PubMed: 2388303]
19. Sharma OP, Scala-Barnett DM, Oswanski MF, Aton A, Raj SR. Clinical and Autopsy Analysis of Delayed Diagnosis and Missed Injuries in Trauma Patients. *The American Surgeon* 2006;72:174–179. [PubMed: 16536252]

Table 1
 Characteristics of Autopsied and Non-Autopsied Patients at Rural Trauma Center

Characteristic	Autopsied	Not-Autopsied	P-Value
Age	45	71	<0.001
Median Hospital Length of Stay	1	4	<0.001
Mechanism - Blunt	78%	83%	0.004
--Burn	12%	8%	
--Penetrating	10%	4%	
Sex (Male)	63%	62%	0.17
Alcohol or substance use	37%	19%	<0.001
Admitted to Trauma	94%	80%	<0.001

Table 2

Odds Ratio of Receiving Autopsy After Traumatic Death at Rural Trauma Center

Parameter	Odds Ratio (95% CI)
Age > 70	Reference Group (Odds Ratio =1)
<20	13.5 (6.1 -- 30.0)
20-44	9.4 (5.2 - 17.0)
45-69	5.7 (3.4 - 9.5)
Length of Stay >8 days	Reference Group (Odds Ratio =1)
0 days (died day of admission)	3.0 (1.6 - 5.8)
1 day	1.9 (1.1 - 3.4)
2-7 days	0.6 (0.3 - 1.1) **
Primary Service (Trauma)	1.9 (0.9 - 4.1) **

All others P<0.05

**
P>0.05.

Table 3
Autopsy Rate and Demographics of Rural and Two Urban Trauma Centers

Characteristic	Rural	Urban 1	Urban 2	P Value
Autopsy Rate	46%	97%	68%	<0.001
Blunt Trauma	83	68	48	<0.001
Penetrating	7	11	49	<0.001
Age	58	50	36	<0.001
Male	65		79	<0.001