FIFTH EDITION

# Trauma Nursing

## From Resuscitation Through Rehabilitation

Karen A. McQuillan
Mary Beth Flynn Makic

With the endorsements of

AMERICAN ASSOCIATION of CRITICAL-CARE NURSES

SOCIETY OF TRAUMA NURSES

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## PART I General Concepts in Trauma Nursing



## PART II Clinical Management Topics



## PART III Single System Injuries



## PART IV Unique Patient Populations

# Trauma Nursing

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# TRAUMA NURSING

## From Resuscitation Through Rehabilitation

Fifth Edition

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To all those colleagues and friends who went before me and serve as role models and mentors, to those who continue to work tirelessly to drive excellence in the care provided to trauma patients and their families, and for those who will follow in our footsteps. Special thanks to my family—my parents, husband, children, and grandson—for their constant love and support.

**Karen A. McQuillan**

To my trauma colleagues, patients, and families who taught me the importance of excellence in trauma nursing care. Thank you for your unwavering efforts in providing exceptional care to trauma patients and their families. To my parents, husband, and children, whose unconditional love and support are ever present in my life.

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# FOREWORD

It has now been 30 years since the initial edition of this text was published. I was honored to be working at the Shock Trauma Center of the Maryland Institute for Emergency Medical Services at the time and was a contributor on Traumatic Brain and Spinal Cord Injuries in the first edition of this premier guide on trauma nursing care.

Since that time, numerous advances in trauma care and namely in trauma nursing have been made. This includes the creation of an association dedicated to trauma nursing—the Society of Trauma Nurses—which in 1987 I was privileged to serve as the first president. More recently, nurses with skill and knowledge in trauma care can now acquire certification in their specialty.

Despite advancements in trauma care and prevention, in 2016 accidental injury became the number three cause of death for the first time in U.S. history. An American is reported to be accidentally injured every second and killed every 3 minutes by a preventable incident. A total of 161,574 preventable deaths from trauma were reported for that year, and over 44.5 million people suffered traumatic injuries. Trauma as a result of urban violence, distracted or drunk driving, improperly used equipment, or inattention to the environment remains an ongoing health care crisis.

Centers such as the Shock Trauma Center in Baltimore have grown over the 30 years since the first textbook was written and will continue to be needed going forward into the future. Dr. Cowley was a visionary, as was Elizabeth Scanlan, the first Director of Nursing at the Center. They not only forged the path for dedicated practitioners in trauma care, they encouraged the development of the first Trauma Nursing textbook. This textbook has been the reference for trauma nurses all over the world through the first four editions.

Trauma nurses possess a specialized body of knowledge for caring for the injured patient. These nurses are a fundamental component of all direct trauma care. From the time the injured patient enters the resuscitation area until they are able to progress through rehabilitation, the trauma nurse is at their bedside assessing, monitoring, and caring for the patient who is in need. Adequate staffing of qualified and certified, trauma nurses is essential for quality care to be delivered to the injured patient. In addition to the physical care nurses provide to the patient, they also provide psychosocial support and comfort to the patient and their families. Nurses also have an integral role in the leadership of trauma centers. Many nurses have led the care and quality efforts in their respective centers. It is truly a calling to be a trauma nurse.

The current editors of this fifth edition of the textbook were also part of the team that did an excellent job with the previous edition. The latest evidence-based practices are brought to this edition of the textbook by the expert contributors. The content will allow the trauma nurse to deliver the high quality of care the victims of traumatic injury need. Since the original textbook was written, trauma care has changed as has the evidence-based practice of trauma nursing. The information contained in this book will guide the nurse through all phases of trauma care, including preventive care, pre-hospital management, resuscitative, operative, critical care, and intermediate and rehabilitative care. The fifth edition will again serve as the comprehensive resource for all trauma nurses—both novice and expert.

I know that trauma nurses are a special group of caregivers. They face a lot of unknowns in the care of patients, because most traumatic injuries are not predicted by or for the patient or their families. The ability to have this fifth edition as the guidebook to trauma nursing will support the care delivered by these dedicated nurses.

It is such an honor to be asked to author the Foreword to this wonderful textbook. Being there more than 30 years ago was an amazing experience for me. I want to thank the editors, contributors, and reviewers for continuing to bring the best practices to Trauma Nursing.

**Connie A. Jastremski, RN, MS, MBA, ANP-CS**

# PREFACE

Expanding evidence, including numerous developments in research, are leading practice changes in the dynamic field of trauma care. The fifth edition of the highly acclaimed text, *Trauma Nursing: From Resuscitation Through Rehabilitation* provides updates to guide nursing practice in the care of injured patients and their families. Like the first four editions of this text, the fifth edition provides a comprehensive description of the art and science of trauma nursing. It builds on the strengths of the previous editions while updating content, expanding on specific topics, and introducing relevant new material.

*Trauma Nursing: From Resuscitation Through Rehabilitation* uses a unique cycle of trauma framework. This format provides the reader with an easy-to-follow organization of material describing evaluation and management of the trauma patient through the continuum of trauma care, including prevention and prehospital considerations; resuscitation; and the operative, critical, intermediate, and rehabilitation phases of care. Evidence-based information about issues that affect trauma care systems, injury pathophysiology, and currently recommended assessment and care of the trauma patient are described for each phase of the trauma cycle.

In addition to updating all of the chapters with current best evidence to guide practice, this edition of *Trauma Nursing: From Resuscitation Through Rehabilitation* added content on cultural sensitivity, care for care givers, and self-harm injuries/suicide—reflecting the greater emphasis on these issues in the current health care environment and the essential roles that nurses have in these areas of trauma care. Where appropriate, chapters were combined to streamline the content, including the evolution of the trauma cycle and nursing practice through the cycle of trauma chapters, the legal and ethics chapters, the prehospital care and rural trauma chapters, and the shock and the multisystem organ dysfunction syndrome and management of traumatic shock chapters. Questions with answers and supporting rationale are found at the end of each chapter so that the reader can assess their comprehension of the content covered in each section of the text.

The text is divided into four major parts:

Part I, General Concepts in Trauma Nursing, covers health care concerns that affect trauma care facilities and trauma systems, ultimately affecting patient care. These concerns include economic and administrative considerations, quality improvement, ethics, and legal issues. Evolution of the trauma cycle, nursing practice through the cycle of trauma care, injury prevention, disaster preparedness, response and recovery for mass casualty incidents, prehospital care, and rehabilitation of trauma patients are also discussed.

Part II, Clinical Management Concepts, addresses specific issues that affect all trauma patients regardless of their injuries. These topics include mechanism of injury; pathophysiology and management of traumatic shock; psychosocial impact of trauma on patients, their family's and care givers; infection; wound healing and soft tissue injuries; nutrition management; and management of pain, anxiety, delirium, and sleep.

Part III, Single System Injuries, describes the pathophysiology, assessment, and state-of-the-art treatment of specific types of systemic injuries throughout each of the phases of trauma care.

Part IV, Unique Patient Populations, reviews the special trauma care considerations and needs of unique patient groups such as pregnant women, children, the elderly, bariatric individuals, burned patients, those with a history of substance abuse, and organ donors.

This text, authored and reviewed by content experts from around the country, will serve as an excellent evidence-based reference for the novice and the experienced nurse caring for trauma patients in a variety of settings. Clinicians, advanced practitioners, researchers, administrators, managers, educators, and students will find this text a useful and comprehensive reference for trauma-related issues. It is our hope that knowledge gained using this resource will enhance your practice and ability to achieve optimal outcomes for your patients as they progress through the cycle of trauma care.

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# The Evolution of Trauma Systems, Trauma Centers, and Trauma Nursing

*Cynthia Blank-Reid*

Traumatic injury has been recognized as a part of the human experience since early civilization. Anthropologic studies of the bony remains of Neanderthal humans have shown members of this group sustained a great deal of trauma during their lifetimes.[1] Disfigured skeletal structures and long-term bony calcification are evidence that the traumatic injury they sustained was the result of the fierce struggle to survive. Many injuries were sustained as the result of their constant exposure to the raw elements of nature and frequent encounters with wild animals.

Although the concept of traumatic injury has been around since the beginning of time, the incidence, magnitude, cause, mechanism, and treatment of traumatic injury *have* changed. Traumatic injury is a major public health problem in the United States and the world and continues to be a health care problem worldwide.[2]

## TRAUMA SYSTEMS DEVELOPMENT

The trauma patient poses challenges to health care systems. In order to recognize and develop a keen appreciation for trauma nursing as a specialty field, one needs to not only review things from a nursing perspective but also look at the historic events that guided the creation of trauma systems. The trauma systems approach to care led to the development of the clinical knowledge base that formed the foundation for the field of trauma nursing.

### Magnitude of the Problem

In the United States, unintentional injury is the most common cause of death for individuals aged 1 to 44 years.[2] The Centers for Disease Control and Prevention (CDC) National Center for Injury Prevention and Control data show us that unintentional injury is the fourth leading cause of death for all ages, exceeded only by heart disease, cancer, and chronic lower respiratory diseases.[2] The primary causes of unintentional injury are

- motor vehicles
- falls
- poisonings
- drowning
- homicides[2]

Although ranked fourth as the cause of death for all age groups, injury is the leading killer of one of our nation's most valued resources—young people. Those between the ages of 1 and 24 years have a greater chance of dying from unintentional injury than from any other cause, and more than three of four individuals in this age group who die from traumatic injury are male.[2]

Trauma is the second most costly medical condition in the United States in regard to health care spending. Estimates place it at over $92 billion in annual expenditures.[3,4] Trauma centers often care for economically disadvantaged and underserved populations. Despite decades of clinical advancement and system development, many challenges remain including securing sustainable funding sources, rural access to trauma care, variable triage accuracy, and dealing with changing patient demographics such as the graying of America.[3,4] All citizens are burdened by the cost of trauma—whether it is through increased insurance cost (health, motor vehicle, etc.), out of pocket expenses, higher prices for goods and services, or through higher taxes and user fees.[3]

In addition to the human loss and disability resulting from trauma, the economic cost also must be addressed. The National Safety Council defines a disabling injury as one that results in some degree of permanent impairment. This includes injuries that render a person unable to effectively perform regular duties or activities for a full day beyond the day of the injury. Cost estimates therefore include the following:

- Wage loss
- Medical expenses
- Insurance administration costs
- Property damages in motor vehicle crashes
- Fire losses

- Indirect work loss (refers to lost work due to injuries that result in money value lost by noninjured workers, including time spent filling out reports or giving first aid to injured workers and time lost as a result of production slowdown)

Understanding the significance traumatic injury has on society includes realizing that the efforts made to prevent injury, disability, and death are integral to advancing trauma nursing practice. The odds are traumatic injury will affect everyone at some point during their lifetime. Even if trauma does not directly injure an individual or their loved one, it will have an economic impact.

## The Military Experience

Before the 1960s, advances in caring for the critically injured were achieved primarily by the military. Injuries sustained by military personnel and civilians during war were the primary focus of studies on traumatic injury and shock. These study findings became the initial source for information regarding the treatment of traumatic injuries.

In 1916, during World War I, the US National Research Council of the National Academy of Sciences formed a committee to collect, review, and analyze objective data regarding the physiology of circulation and shock.[5] This was the first coordinated prospective study organized for the purpose of obtaining a better understanding of the body's responses to severe trauma.

During World War II, the care of patients who were wounded and went into shock improved significantly, largely due to the prompt application of information obtained by the Medical Board for the Study of the Treatment of the Severely Wounded.[6] This 22-member board was appointed in 1943 and was made up of medical officers, nurses, technicians, and support personnel who worked as a research team. In response to medical requests from the field, this team compiled and analyzed casualty data which lead to a change in policy regarding the treatment of hypovolemic shock. The data from observations of 186 military casualties comprised the first volume of the historic series by the Medical Department of the United States Army. It was titled *Surgery in World War II: The Physiologic Effects of Wounds.*[6] Resuscitation practices improved as hemodynamic alterations become better understood and knowledge about posttraumatic renal failure, an often fatal complication of severe shock, emerged. The policy change regarding the treatment of hypovolemic shock initiated by this study resulted in improved survival.

A similar but more extensive research program was established during the Korean War (1950–1953) and later during the Vietnam War (1957–1975).[5] Newly formed surgical research teams were developed to study and advance knowledge for military medicine during the 20th century. Research findings of the team contributed to further refinement of care delivered to trauma patients during the Korean War. Progress was made in the clarification of the hemodynamic disturbances that occur with different forms of traumatic injury, organ function, and the metabolic disturbances in shock and acute circulatory failure.[5]

The pressing demands of surgery during war, coupled with the advances in medical care that occurred during the previous century, contributed in part to the improved trauma outcomes that were realized during the Vietnam War. Improvements in field resuscitation, transportation efficiency, and aggressive treatment of the injured proved to be major factors contributing to life-saving endeavors. The death rates of war casualties reaching designated facilities decreased from 8% in World War I to 4.5% in World War II, to 2.5% during the Korean War, to less than 2% in the Vietnam War.[7]

Experience in caring for battlefield injuries sustained during the wars in Iraq and Afghanistan also offers new knowledge and expertise that can help to improve treatment outcomes for the injured. For example, a large number of military personnel have been exposed to blasts causing significant injuries, particularly affecting the brain. This has prompted investigations into how to best care for victims of blast injuries and development of evidence-based *Guidelines for Field Management of Combat-Related Head Trauma.*[8] Further knowledge about the effectiveness and risks of agents such as tranexamic acid (TXA) and tourniquets to stop bleeding are also being realized.[9,10] These and other revelations made during wartime are considered in determining the best trauma care practices for those injured and cared for on and off the battlefield.

## The Military Influence

With the return of the medical providers after the Vietnam War, it became clear that our national health care delivery system needed changes based on what was learned about the significance of time in saving lives and the physiologic responses to injury. The need for an effective system to care for the severely injured was just as pressing in the civilian sector as in the military arena. The rapid evacuation of the seriously injured from the battlefield to advanced treatment stations (mobile army surgical hospital units), which were equipped with necessary supplies and staffed with highly skilled personnel, saved lives. Although long overdue, the principles on which this system was designed have been transferred to the civilian life. The modern era of a civilian systems approach, which focused on more efficient emergency health care for the injured, began in 1966 with the publication of a document by the *National Academy of Sciences, National Research Council, Accidental Death and Disability—The Neglected Disease of Modern Society.*[11] This document provided a far-sighted approach to the development of an effective emergency medical services (EMS) system throughout our nation. The outcome of this study reviewed the status of initial emergency care after "accidental" injury. The study groups reviewed a broad spectrum of factors, including ambulance services, voice communication systems, hospital emergency departments (EDs), and intensive care units (ICUs), while incorporating research results in shock, trauma, and resuscitation. Deficiencies identified for improvement included the following:[12]

- "Accident" prevention
- Emergency first aid and medical care

- Ambulance services
- Communications
- ED
- Interrelationships between the ED and the ICU
- Development of trauma registries
- Hospital trauma committees
- Convalescence, disability, and rehabilitation
- Medicolegal problems
- Autopsy of the victim
- Care of casualties under conditions of natural disaster
- Research in trauma

Contributing significantly to the high mortality and morbidity rates was the inefficiency in the nation's emergency health care delivery system. Unskilled health care personnel working with inadequate transportation, communication system policies, and guidelines were taking the injured to facilities that were not prepared to treat them. The problems of initial care and management of injured persons were similar in kind, although different in magnitude and scope, to those encountered by the military during periods of war. The national effort for establishing an improved emergency health care system and much of the basic framework on which the nation's EMS system has subsequently been built were a result of this seminal document reviewing trauma care.[11–13]

## Early Pioneering Efforts

During the late 1960s and early 1970s, the need for a systematic approach to the care of the seriously injured patient became apparent. The initial efforts to design and develop emergency medical clinical delivery systems were based on the care requirements of specific types of injury (e.g., burns, spinal cord injuries).[11,14] This systems approach required effective medical and surgical treatment regimens be applied in situations other than the traditional in-hospital setting. This necessitated the reorganization of existing health care structures, the implementation of new technologies, and the development of educational programs so that clinical treatment modalities proven effective in the hospital environment could be applied and tested in the prehospital and interhospital phases. Physician-supervised educational programs and out-of-hospital emergency care programs began to emerge, with emergency medical technicians-ambulance (EMT-A) and advanced life support emergency medical technicians-paramedic (EMT-P) assuming key roles.[12,13]

In several parts of the country, hospitals were categorized regionally, and those with demonstrated expertise were designated as trauma, burn, or spinal cord injury centers. In Illinois, in 1971, the regionalization of emergency care for multiple and critical injuries was initiated.[12] As the Illinois trauma program began to develop and mature, a program of patient transfer and burn center care also was initiated for the four burn units and major burn center (Cook County Hospital) in Chicago, which used a patient distribution program and central bed registry.[14] In 1973, the shock-trauma program of the University of Maryland, supported by the Maryland state government, was expanded statewide and became the Maryland Institute for Emergency Medicine (MIEM).[15]

These pioneering efforts were significant because they represented working models for further regional trauma/EMS systems development. The apparent successes resulting from these system designs became the catalysts for an intense national effort to plan and implement trauma/EMS systems.

## Federal Support of Trauma and EMS Systems

Federal support started during the early 1970s, when congressional hearings were held to promote development of a comprehensive EMS law. In 1973, the Emergency Medical Services Systems (EMSS) Act was passed, which contained guidelines and specific technical measures that supported a nationally coordinated and comprehensive system of emergency health care accessible to all citizens. The identification of fundamental elements of the EMS system deemed necessary for the comprehensive care of the critically ill and injured was accomplished with this mandate. Included in the EMSS Act were 15 requirements (Box 1.1) that would assist EMS system project planners and health care professionals in establishing comprehensive, area-wide, and regional EMS programs.[16]

The 1973 EMSS Act, with its subsequent changes in 1976, is considered one of the most important factors influencing the development of EMS systems in this country. This act mandated that emergency medical care programs that were federally funded by the Department of Health and Human Services (DHHS) must plan and implement a systems approach on a regional basis for emergency response and immediate care provisions.[17] It was determined there would be seven critical target patient care areas for regional EMS systems planning: major trauma, burns, spinal cord injuries, poisonings, acute cardiac conditions, high-risk infants and mothers, and behavioral emergencies.

The federal government withdrew from its lead role in EMS development in 1981 with the passage of the *Reconciliation Act,* which integrated the EMS program into the Health

**BOX 1.1 Emergency Medical Systems Act 1973 Requirements**

- Provision of manpower
- Training of personnel
- Communications
- Transportation
- Facilities
- Critical care units
- Use of public safety agencies
- Consumer participation
- Accessibility to care
- Transfer of patients
- Standard medical record keeping
- Consumer information and education
- Independent review and evaluation
- Disaster linkage
- Mutual aid agreements

Prevention Block Grants and gave responsibility back to the states for direction and development of EMS. This led to the realization that parts of the United States did not have 911 access or a formal developed trauma care system, and many rural areas did not have advanced life support ambulances. An attempt to correct these issues was made with the passage of the Public Law 101-590 *Trauma Care Systems Planning and Development Act of 1990.* This legislation was significant because it provided federal assistance for the development of emergency/trauma care systems throughout the United States. The act authorized the DHHS, through the Health Resources and Services Administration (HRSA), to make grants to states for trauma systems planning and development. The major provisions of this act included:[17,18]

1. *A council on trauma care systems:* Report the needs of the trauma care system and how states are responding to such needs. This council has 12 public members, including two nurse positions (one critical care and one emergency medical training position).
2. *A clearinghouse on trauma care and EMS:* Created by a contract with an outside entity a way to collect, compile, and disseminate information relating to all aspects of EMS and trauma care.
3. *Programs for improving trauma care in rural areas:* Grants are authorized for public and private nonprofit entities for research and demonstration projects that will improve the availability and quality of emergency medical/trauma care in rural areas.
4. *Formula grants with respect to modification of state plans:* Most of the appropriated funds (80%) will be allotted by formula for each state and territory. Beginning in the second fiscal year that states receive funds, they must make a matching nonfederal contribution (in cash or in kind) in specified ratios.
5. *State plans and modifications:* Each state must submit to the Secretary of Health and Human Services the trauma care component of the state's EMS plan. The funds allotted for each state may be used only to make such modifications to the state plan as are necessary to ensure access to the highest quality of trauma care.
6. *Trauma care standards and a model trauma care plan:* Each state must adopt standards for designating trauma centers and for triage, transfer, and transportation policies.
7. *Data and reporting requirements:* Each state must report annually to the Secretary the number of severely injured patients; the cause of injury and contributing factors; the nature and severity of the injury; monitoring data sufficient to evaluate the diagnoses, treatment, and outcomes of such trauma patients in each trauma center; and expenditures.
8. *Technical assistance and supplies and services in lieu of grant funds:* The Secretary shall provide technical assistance with respect to planning, development, and operation of any program carried out with the allotted funds, at no charge to the state.
9. *Waiver:* Under certain limited conditions, the Secretary may allow a state to use a percentage of allotted funds to reimburse designated trauma centers for uncompensated care.

Mandates within the *Trauma Care Systems Planning and Development Act* also required administrative components be addressed: leadership, system development, legislation, and finance. The operational and clinical components that were to be addressed in trauma programs included public information/education and prevention initiatives, human resources, prehospital care, EMS medical direction, triage, transport, definitive care facilities, interfacility transfer, medical rehabilitation, and evaluation.[19,20] The primary focus of this model was to ensure essential elements of trauma systems. Unfortunately, both federal and state funding throughout the decades has been sporadic resulting in challenges for consistent trauma and EMS services throughout the United States.

In 2016, an update to the *Model Trauma System Plan* was published. The revised document, *Model Trauma System Planning and Evaluation,* based on input from 41 states, provides a summary assessment of trauma system planning, development, and evaluation of trauma programs/systems.[16] Two key points noted in this publication were that formal trauma systems do not exist in all states and the state EMS offices are not always the administrative repository of all trauma system components. In some cases, elements of the trauma system such as prevention, data analysis, and disaster preparedness are organizationally situated elsewhere. The second point was that because the state trauma systems that do exist evolved more or less organically, the systems are often not directly comparable. Each system has standards, criteria, and requirements that have been uniquely developed to meet the political and fiscal realities of each state. This is true of state EMS systems in general. As a result, the definitions of terms, the inclusion and exclusion criteria for data systems, and processes for recognition of trauma centers are all quite different.[16,21–23] The document's goal is to provide a clearer understanding of what exists and to describe the challenges and opportunities of further system development that can be more fully appreciated.[23,24]

## Trauma/EMS System Development

As EMS systems developed, the key components for the care of the trauma patient population became facility categorization and trauma center designation (Table 1.1). Established triage and transfer protocols are critical to ensure that immediate intervention is consistent and decision(s) regarding transfer to a designated trauma facility for definitive care are facilitated. Thus it is of utmost importance that regional trauma/EMS systems plan and develop clinically sound trauma care programs on a geographic basis. Because of the complex requirements, the care of the trauma patient has provided an excellent model from which to design a basic health care delivery system. This has since been expanded to include other types of emergency medical conditions such as stroke and myocardial infarction requiring a cardiac catheterization.[17]

The clinical significance of the systems approach in developing a regional trauma/EMS system was clearly identified by

**TABLE 1.1 Key Components of a Clinical Emergency Medical Services System**

| | |
|---|---|
| Trauma | Facilities categorization |
| | Trauma center designation |
| | Transfer agreements and triage protocols |
| Cardiac Emergency | Patient access (911) |
| | Citizen cardiopulmonary resuscitation (CPR) |
| | Advanced cardiac life support (ACLS) paramedic response |
| Poisonings | Information specialists |
| | Toxicologic information and treatment protocols |
| | Telephone-directed home care and physician consultation |

From Boyd, D. R., Edlich, R. F., & Micik, S. (1983). *Systems approach to emergency medical care.* Norwalk: Appleton-Century-Crofts.

the Division of Emergency Medical Services of the DHHS and reflected in their program guidelines.[17] Emphasis was placed on the need to effectively identify the critical patient whose chance of survival desperately depended on a competent trauma care delivery system. It was toward increasing the chance of survival for these critical patients that conceptual system planning and initial program development were directed.

### Facilities Categorization

In 1976, the American College of Surgeon's Committee on Trauma (ACS-COT) published the "*Optimal Hospital Resources for Care of the Seriously Injured,*"[20] which called for hospitals to commit personnel and facility resources to caring for seriously injured patients. Emphasis was placed on special problems of geography, population density, availability of community and regional resources and personnel, and the pervasive demands for cost-effectiveness, with the most significant element being commitment, institutional and personnel. Institutional commitment was defined as the immediate availability of capable personnel and accessibility to sophisticated equipment, laboratory and radiologic facilities, operating rooms (ORs), and ICUs.

### Trauma Center Designation

The ACS-COT *Resources for the Optimal Care of the Injured Patient* (2014)[21] is the sixth revision to the 1976 document and emphasizes the development of a trauma system rather than a single trauma center. For optimal trauma care, a community must develop an all-encompassing systems approach to provide the appropriate level of trauma care. This system of care involves a lead-governing agency for development and oversight, a prehospital emergency care system, and a network of hospitals that provide a spectrum of care to all injured patients. Each hospital within the definitive care network is identified as Level I, II, III, or IV, depending on the depth of resources available to care for the trauma patient.[25]

- A *Level I* facility is a regional resource trauma center that is a tertiary care facility central to the trauma care system. This facility must have the capability of providing leadership and total care for every aspect of injury, from prevention through rehabilitation. The hospital has a major obligation to provide education, research, and system planning in a regional trauma care system.
- A *Level II* facility is a hospital that also is expected to provide initial definitive trauma care regardless of the severity of injury. The level II can be an academic institution or a public or private community facility, most likely a tertiary institution that may or may not be an academic center. It is expected that the Level I and Level II facilities work together to optimize resources in the region to provide the appropriate level of care for all injured patients. When the Level II trauma center is located in a more rural setting or is the only tertiary hospital in a region, it serves as the lead trauma facility for that region.
- A *Level III* facility serves communities that do not have immediate access to a Level I or II institution. They provide prompt assessment, resuscitation, emergency operation, and stabilization and transfer to a facility that can provide definitive trauma care when needed.
- A *Level IV* facility is generally a small hospital or clinic in a rural or remote area. This center is part of a regional trauma care network and will have transfer agreements with Level I and II centers. The Level IV center provides timely resuscitation and transfer of most injured patients.

Many other hospitals, both large and small, have ED capabilities but have made no official commitment to an organized approach to the care of the seriously injured patient. This type of institution is an implied Level IV trauma center and requires strict treatment protocols and transfer agreements with higher-level facilities.

The intent of the guidelines outlined by the ACS-COT is to encourage each hospital to constantly monitor its capabilities as a trauma care facility and strive to continually improve patient care. Ideally, if the guidelines are actualized, the severity of injury should be matched equally with appropriate facility resources and personnel expertise. Health care professionals who work at a trauma center are educated and skilled in managing the special problems of trauma patients and have a well-defined role on a team organized to provide optimal care. When care is provided by knowledgeable health care professionals at a trauma center, patients will likely have more favorable outcomes than when care is provided by those who view trauma care as another general service.

Over the past two decades because of natural disasters, violent crimes, acts of terrorism, and industrial/work situations, there has been an increased need for disaster, multiple and mass casualty planning. These types of situations can occur naturally due to the environment or be man-made. They can occur internally to a facility or externally, and they can last hours to days. To devise a comprehensive strategy, all the potential disaster situations described require a cooperative interprofessional effort by local medical resources, fire, EMS, and police departments; local, regional, state and national

governments, and industry. The importance of realistic practice drills cannot be emphasized enough. For further information on this topic, please refer to Chapter 7 on Mass Casualty Incidents.

### Transfer Agreements and Triage Protocols

The relationship of a regional trauma/EMS system to the overall EMS system is an important consideration as trauma/EMS systems involve a complex series of events that must be coordinated effectively to provide a consistent mechanism of response and health care delivery. Trauma care research has shown that the standard mortality curve necessitates rapid intervention from time of injury to treatment to reduce overall patient morbidity and mortality.[26] Patient survival is improved when resuscitation and stabilization efforts are initiated early and sustained. A prompt trauma/EMS system response, provision of initial basic field care, use of a sophisticated communications system, and rapid and safe transport of the patient saves valuable time and death may be prevented. Each phase of EMS activity has a critical effect on mortality.

The EMS process begins when notification is received by EMS system operators that an injury incident has occurred and a first responder team is dispatched to the scene. Each regional trauma/EMS system must be organized in such a way as to accommodate the unique needs of the area. Generally, attempts are made to centralize designated trauma or specialty care facilities within regional trauma/EMS systems to facilitate timely and efficient primary triage or secondary transfer of patients, if needed. Protocols are used for field identification, triage, resuscitation, and transportation to designated trauma centers. These protocols not only facilitate consistency within the trauma/EMS system but also ensure the injured patients are taken to the appropriate level of trauma service hospital capable of continuing and expanding life support measures initiated in the field.

The trauma facility notified of a pending admission has the responsibility of alerting the in-house trauma team to prepare for the patient's arrival. Staff specialists and expert clinicians, equipment, supplies, and ancillary support systems must be immediately available if the complex problems of the seriously injured patient are to be properly managed in a timely fashion. Effective resuscitation and stabilization efforts are based on the implementation of a predetermined series of activities performed simultaneously by appropriate trauma team members. Nurses specializing in trauma care are essential members of the team receiving the patient and providing specialized trauma care throughout the hospitalization.

Advances in the trauma/EMS system, by design, provide immediate and appropriate care at the scene, safe and efficient transportation to the appropriate trauma center, definitive diagnostic and surgical interventions, critical care management, acute care, and rehabilitation services. This broad scope of capabilities is essential to match the needs of the patient to the services the receiving hospital can provide.

The challenge for future trauma system development and maturation will depend on society's commitment of resources. Outcomes of the trauma system's performance must have data-driven interprofessional evaluation that looks not only at mortality rates but also includes functional patient outcomes and the efficient use of resources needed to achieve them.[22,24] Advances in triage protocols and transfer agreements to the appropriate level of trauma care improve outcomes.[25]

Ongoing advancements in the science of trauma have enabled significant accomplishments throughout the past century in advancing trauma care. EMS response services will continue to be developed as we to strive to standardize the evidence-based clinical care of trauma patients to improve outcomes.[26] The National Academies of Sciences, Engineering, and Medicine (NASEM) is guiding the next wave in trauma care encouraging the integration of military and civilian trauma systems to achieve zero preventable harm.[27] Trauma nurses are integral to achieving this goal.

## THE EVOLUTION OF TRAUMA NURSING

### Historic Background

Nurses have long been at the forefront caring for seriously injured patients and their family. Because wars have been responsible for producing traumatic injuries in epidemic proportions, military nurses for years had the most experience in caring for the wounded. Many would argue that military nurses were the first organized group of trauma nurses. Trauma nurses were first organized in the United States by George Washington during the Revolutionary War when he hired women to provide care to his wounded troops.[28] The first organized nursing effort focusing on battlefield injuries was pioneered during the Crimean War (1854), when Florence Nightingale, Lady Superintendent-in-Chief of female nursing in the English General Military Hospitals, led a group of women in caring for war casualties.[29] For approximately 2 years, this group of nurses provided makeshift hospital facilities; bathed and dressed wounds; and painstakingly sought proper sanitation, hygiene, and control of infection. In 1861, Nightingale was asked by the US Secretary of War for advice on setting up military hospitals for the Union army, and her suggestions were widely adopted throughout the course of the Civil War (1861–1865).[30] Clara Barton, the first woman clerk of the US Patent Office, served as a nurse caring for wounded men on the battlefield after the outbreak of the Civil War in 1861 and later during the Franco-Prussian War (1869). In 1881, after her return to the United States, Barton organized the American Red Cross, a volunteer society modeled after the International Red Cross, which was established in 1863 by Jean Henri Dunant.[31]

In subsequent wars, nurses cared for the wounded on and off the battlefield, seeking new ways to manage the devastating injuries resulting from the ever-increasing power of weaponry. Under the most adverse circumstances, combat nurses worked to salvage mutilated extremities and replace massive losses of blood. While caring for the wounded, nurses came to understand the long-term effects and difficulties their patients faced as a result of war.[32] Enormous

problems existed for nurses who cared for the wounded. The scars of battle extended far beyond those from burns, bullets, or blasts. The psychologic implications for nursing care continue to be just as pervasive as the physical demands.

The knowledge gained from the experiences of the front-line nurses has provided valuable information in helping to understand trauma in civilian life. Military nurses continue to contribute to the advancement and the development of innovative improvements to trauma nursing care. The changing war theaters and fighting tactics seen in Vietnam, Desert Storm, Somalia, Afghanistan, and Iraq continue to provide not only challenges to patient care but they offer an ever-changing opportunity to address new and improved nursing treatment protocols for trauma care.

## Evolution of the Trauma Resuscitation Team

In the late 1960s and 1970s, the categorization of hospital facilities had been one strategy demanded by the federal government to ensure that patients were taken to institutions most capable of caring for their injuries. A few facilities throughout the country began to make tremendous advances in caring for seriously injured trauma patients. Because these institutions cared for a large number of injured patients, they developed a staff of physicians and nurses proficient in caring for complex injuries. Data from these institutions began to indicate that mortality and morbidity rates were substantially lower in the hospitals that had more qualified and experienced personnel and more extensive resources.[32–36]

The success of the trauma team depends not only on the knowledge base and skill level of each physician and nurse but also on the consistency and repetition of their practices as a team. Proven in both military and civilian settings, a dedicated trauma team approach is the most effective and efficient means to care for the critically injured trauma patient. The predetermined delegation of specialized role responsibilities starting with EMS first responders to each nurse and physician team member fosters the efficient organization of talents, which decreases the time between the patient's early interventions being initiated, hospital arrival, and the onset of definitive care. The hospital's trauma team effort to save lives continues to best support the life-sustaining activities after traumatic injury.

## Trauma Nursing

As military nurses returned to civilian life, they too began to realize, just as their physician counterparts, that there was an incredible void in the care being given on the home front. Due to these pioneering military nurses and their civilian counterparts, the specialty of trauma nursing began to evolve.[30] Over the past few decades, trauma nursing has progressed into a specialty practice. Milestones in the evolution of trauma nursing include numerous achievements and advances that positively impact nursing practice (Table 1.2). Evolution achievements included but were not limited to the founding of the Emergency Nurses Association (ENA) in 1970, which was instrumental in initiating trauma nursing

**TABLE 1.2 Milestones of Trauma Nursing**

| | |
|---|---|
| 1854 | Florence Nightingale tends to wounded soldiers in the Crimean War. |
| 1861 | Clara Barton tends to wounded soldiers during the US Civil War. |
| 1901 | US Army Nurse Corps established as a permanent corps within the US Army Medical Department. |
| 1961 | First shock trauma nurses. Elizabeth Scanlan, RN, and Jane Tarrant, RN, pioneered the nurse's role in the first two-bed shock/trauma research center with R Adams Cowley, MD, at University of Maryland Hospital, Baltimore, Maryland. |
| 1963 | National Research Center awarded a first-of-a-kind grant to the University of Maryland in Baltimore to establish a center for the study of trauma. |
| 1966 | Cook County Hospital in Chicago opened a trauma unit with Robert Freeark, MD, as medical director and Norma Shoemaker, RN, as nursing supervisor. |
| 1966 | *Accidental Death and Disability: The Neglected Disease of Modern Society* (white paper on trauma) published, citing needs of trauma population. This led to federal funding of trauma centers. |
| 1970 | Emergency Department Nursing Association founded by Anita Dorr, RN, and Judith Kelleher, RN. This would develop into the Emergency Nurses Association (ENA). |
| 1971 | First trauma nurse coordinators hired for Level I trauma centers in Illinois. David Boyd, MD, hired Theresa Romano, RN, to direct the education and training of nurses working in the designated trauma centers in Illinois. |
| 1973 | Federal contracts awarded to Texas Women's University, University of Cincinnati, and University of Washington to begin graduate nursing programs in burns. These programs were the model for the first graduate trauma nursing programs. |
| 1975 | Maryland state EMS system established trauma nurse coordinator position for training, designation, and evaluation. |
| 1982 | Advanced Trauma Life Support (ATLS) for nurses (pilot program) taught in conjunction with physician course. Nursing track was developed by Maryland Institute for Emergency Medical Services Systems (MIEMSS) Field Nursing, Baltimore. This tract would develop into the Advanced Trauma Care for Nurses (ATCN) course. |
| 1983 | Trauma Nurse Network organized to provide a communication link for trauma nurses. This organization would become the Society of Trauma Nurses (STN). |
| 1986+ | Trauma Nurse Core Course (TNCC) implemented by the ENA. |
| 1987 | First national census forum on Development of Trauma Nurse Coordinator Role is held in Washington, DC. |
| 1989 | Due to membership growth, the need for a more structured organization, and the increase in the diverse role of the trauma nurse, STN is formed. The annual meetings and conferences are held in collaboration with physician trauma conferences. |
| 1993 | STN publishes the inaugural issue of the *Journal of Trauma Nursing (JTN).* |

*Continued*

**TABLE 1.2 Milestones of Trauma Nursing—cont'd**

| | |
|---|---|
| 1997 | STN has its first national conference as a standalone meeting. |
| 2000 | STN collaborates with the American College of Surgeons Committee on Trauma (COT) and Advanced Trauma Life Support (ATLS) Committees to provide ATCN courses. |
| 2005 | *JTN* publishes "The evolution of trauma nursing and the Society of Trauma Nurses: a noble history," which was written by Mary Beachley, October 2005. |
| 2006 | Formal collaboration initiated between STN and the Eastern Association for the Surgery of Trauma (EAST) to join the EAST's Annual Scientific Assembly meeting and hold concurrent STN sessions for Advanced Practice Nurses and physician assistants (PAs). |
| 2015 | STN collaborates with the Board of Certification of Emergency Nursing (BCEN) to develop, implement, and run a national certification program for trauma nurses. The Trauma Certified Registered Nurse (TCRN) begins. |
| 2017 | Due to the increase in international membership, the STN Board of Directors (BOD) forms an international council, which is comprised of STN members from various countries around the world. The council reports directly to the International Director at Large and advises the STN BOD on international trauma issues. |
| 2018 | STN and the American Association for the Surgery of Trauma (AAST) collaborate to co-host the 4th Annual World Trauma Congress in San Diego, CA. |

education. The ENA also developed the Trauma Nursing Core Course (TNCC) in the mid-1980s. The Trauma Nursing Network was started in the early 1980s and was originally designed to be a way for Trauma Nurse Coordinators to network, communicate, and share their expertise with each other. The Trauma Nurse Network evolved into the Society of Trauma Nurses (STN) in the late 1980s and would develop the Advanced Trauma Care for Nurses (ATCN) in the early 1990s. STN has evolved into an authority, advocate, lobbyist, and voice for trauma nursing. Both TNCC and ATCN have become important educational programs to trauma nursing and are offered throughout the world. They standardized the core level of knowledge needed in implementing the trauma nursing process, advanced critical thinking skills, and in measuring competency in trauma care.

As trauma nursing progressed into a specialty practice, STN developed the essential resource, the *Journal of Trauma Nursing (JTN)*, which evolved into a national and international resource for trauma nurses. The past decade has seen the creation of the Trauma Certified Registered Nurse (TCRN) certification designed to assess and validate the nurses' competency and knowledge in caring for trauma patients across the continuum of care. All of these accomplishments are hallmark achievements of trauma nursing practice.

The uniqueness and complexity of patients with multiple injuries has resulted in trauma nursing evolving into more than nursing practice only in the resuscitation area. Instead, specialty trauma nursing care extends throughout all subsequent phases of the trauma continuum—critical care, intermediate and acute care, rehabilitation, and integration into society. One of the most challenging aspects of caring for trauma patients is the development of a plan of care that addresses the patient's needs in a logical, organized fashion to ensure continuity and coordination of all health care disciplines. Formulation of such a plan requires incorporation of the five components of the nursing process: assessment, diagnosis, planning, implementation, and evaluation. In addition, nursing management is inextricably intertwined with and reflective of the plans of other trauma team members as the overall plan of care is developed and implemented throughout the cycle of trauma care.

The coordination of patient care requires nurses with a wide range and breadth of knowledge and skills. Trauma nurses must understand the significant impact that traumatic injury has on the patient, the patient's family, and society. They must be adept at sophisticated monitoring, caring for the intense physiologic needs, and be able to respond to the psychologic and social demands of the patient. They also must be able to assist the family in coping with the stress and emotional devastation that accompany a sudden traumatic event. Patient and family recovery are heavily dependent on the skills of the nurses as caregivers, communicators, collaborators, and coordinators throughout the cycle of trauma.

The critical care phase of patient care has provided unique challenges for nurses as new concepts of physiology and biochemistry are applied in care delivery as well as new assessment techniques and management therapies are introduced. With the advent of technologic advances affecting physiologic monitoring and diagnostic procedures and improvements in medical treatments, trauma nursing began a new frontier. One of the natural outcomes of this rapidly expanding technology was the nurse's increasing responsibility for making complex decisions that directly affect the treatment outcome. Because nurses are at the bedside on a 24-hour basis, they are in the position to facilitate the coordination of interprofessional patient care activities for the injured patient. The role of the trauma nurse has evolved over the years from that of reporting changes to the provider to that of having problem-solving and decision-making responsibilities in a partnership with the rest of the health care team.[30] As the trauma nursing specialty practice was being developed, advanced practice roles emerged for nurses.

The trauma coordinator, trauma program manager, and trauma clinical specialist roles were created in the late 1970s to early 1980s. The roles varied institution to institution, but the main focus was to ensure that the patient received the highest quality care available and that it was constantly being evaluated for opportunities for improvement. As facilities grappled with financial reimbursement issues, the use of

acute care trauma nurse practitioners (NPs) and physician assistants (PAs) as active care providers was instituted.[37]

Current advances in trauma nursing include development and use of evidence-based treatment algorithms to guide care and provide nursing autonomy in making and implementing treatment decisions. Nurses in collaboration with other members of the health care team identify and incorporate best-practice guidelines for patients to avoid complications and decrease length of stay.

## NURSING PRACTICE FROM TRAUMA RESUSCITATION THROUGH REHABILITATION

### Field Stabilization and Resuscitation

The ultimate goal in the prehospital phase of trauma care is to stabilize and transport the multiply injured patient to the appropriate level trauma center via the safest and most rapid transport mode.[17,38] Accomplishing this requires collaboration that begins at the scene where the patient is injured. Effective communication is central to trauma care success. An effective EMS system allows trained prehospital personnel to communicate with emergency providers at the receiving hospital and a centralized communications center to assist in planning the appropriate mode of transport for that patient. Conditions at the scene also may require additional personnel to help with extrication, crowd control, or directing traffic to prevent further injuries. Physicians and nurses who are part of "go teams or surgical response teams" may be sent to the scene to provide needed expertise in the field when special situations occur such as a prolonged complex extrication. In addition, flight nurses and providers who staff hospital-based air evacuation programs are in widespread use across the country. The three priorities for the prehospital providers at arrival on the scene are (1) scene assessment, (2) evaluation of individual patients, and (3) recognition of possible multiple patient involvement and mass casualty incidents.[15,17,35]

### Developing and Implementing the Plan of Care

In the prehospital phase of care, a primary objective is to prevent further injury. Care in extricating and transporting patients to avoid further injury and complications cannot be overemphasized. Effective triage is vital to ensuring that the patient is transported to the most appropriate facility based on the injuries present and the medical history obtained. Triage protocols are defined within each jurisdiction or state EMS system. Once the appropriate level of trauma center is identified, decisions about the mode of transport are made based on the weather and the patient's condition.

Documentation from the field is very important. Prehospital records should become part of the patient's permanent medical record and offer insight as to the patient's condition prior to arrival at the hospital. After the patient has reached the trauma facility, the trauma team reviews the prehospital care. If concerns in care are identified, they should be dealt with through the Performance Improvement and Patient Safety program (PIPS). This is essential for improving quality in the trauma system as a whole as EMS providers are key stakeholders in trauma center PIPS program.[21]

An effective plan of care for the trauma patient begins at the scene of the injury. In the 1970s, Dr. R. Adams Cowley, father of the "golden hour" concept, found that multiple trauma patients who received definitive care within 60 minutes of their injuries had the best chance for recovery.[15] Advances in trauma care have helped accomplish the golden hour concept to advance patient survival.

## IN-HOSPITAL RESUSCITATION AND OPERATIVE PHASE

Because the patient often arrives at the receiving facility from the scene with little of the golden hour remaining, immediate life-saving measures are required. A coordinated, collaborative, unified approach is the cornerstone of trauma patient care in the resuscitation area. Philosophically, all trauma patients are in critical condition until proven otherwise. Advanced preparation to allow immediate access to equipment, supplies, and personnel is essential. This is made possible by prehospital providers' notification of the patient's pending arrival at the trauma center.

### Preparation and Initial Contact

The resuscitation nurse plays a vital role prior to the patient's arrival. Receiving prior notice of a patient's arrival allows preparation of routine equipment and supplies required to care for the patient. Preassembled sterile instrument trays should be readily available to save valuable time. Trauma patients frequently require surgical management; thus notification to the surgical team and operating room staff should be initiated. The resuscitation area is inspected to ensure all required supplies are available: the bedside monitor, suction apparatus, and intravenous (IV) lines primed with the appropriate fluids. Additional equipment is prepared based on specific information obtained from field personnel.

Members of the trauma team are notified and must be present when the patient arrives. In major trauma centers this team usually consists of an attending trauma surgeon or emergency medicine physician, residents (if the facility has them), one or two nurses, a respiratory therapist, anesthesia personnel, and a patient care technician. Response times and presence of these individuals are dictated and monitored by the trauma center verification or designation process. Preparation includes donning of appropriate protective attire (goggles/face shield, mask, gloves, and water-impervious cover gown) before the patient's arrival so that the team is protected from bodily fluids as well as chemicals and other hazardous things. Each member of the team is assigned a specific role during the resuscitation, which is determined before the patient arrives.

Some patients may be initially treated and stabilized in a facility that does not have a full complement of trauma services and then transferred to a higher level of care. Before