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REVIEW

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Total care of trauma patients from triage to discharge at Chang Gung Memorial Hospital: introducing the development of an iconic acute care surgery system in Taiwan

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Abstract

Background The Acute Care Surgery (ACS) model has evolved to provide structured care across trauma, critical care, and emergency general surgery. This innovative model effectively addresses significant challenges within trauma care. Research indicates that trauma surgeons operating under this expanded scope deliver high-quality care while enjoying professional satisfaction. This article discusses the introduction of the ACS model in Taiwan.

Main Body Before the 1990s, Taiwan's trauma care system relied on general surgeons who operated under an "on-call" model, lacking dedicated trauma specialists. Significant reforms were initiated in 2009, when the government implemented a grading system for hospital emergency capabilities, categorizing hospitals into three levels: General (offering 24 h services), Intermediate (capable of managing stable trauma cases), and Advanced (providing comprehensive care for critically ill patients). All medical centers are classified as advanced level hospitals and are equipped with trauma teams. However, these trauma teams operate under various models, ranging from those focused exclusively on trauma to others with comprehensive responsibilities. The trauma center at Chang Gung Memorial Hospital (CGMH) adopted a comprehensive ACS model, encompassing the entire spectrum of care from emergency admission to discharge, all led by trauma surgeons. This approach ensures continuity and coordination in trauma patient care. Additionally, the model integrates emergency general surgery and surgical critical care, broadening the scope of practice for trauma surgeons and enhancing their overall capabilities, providing significant flexibility in their career paths. The ACS model implemented at CGMH has achieved remarkable success, establishing it as a leading trauma center in Taiwan.

Conclusion The emergence of the ACS model aims to reverse the decline in the trauma field that began decades ago. This model not only helps retain skilled professionals but also maintains the expertise of trauma surgeons, ensuring that trauma patients receive the highest quality of care.

Keywords Acute care surgery, Trauma surgery, Emergency general surgery, Surgical critical care

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The evolution of acute care surgery in North America and around the world

Acute care surgery (ACS) has centered around three core pillars: trauma, critical care, and emergency general

surgery (EGS). This ACS model reflects the ongoing advancements in modern healthcare, which is striving to deliver the highest quality of care for these specific patient groups [1, 2].

In the realm of trauma surgery, significant challenges have emerged owing to its evolving perception as a predominantly nonoperative discipline. Today trauma surgeons often act as coordinators, making critical decisions during the resuscitation phase, yet rarely participate in surgeries [3]. This shift means that trauma surgeons frequently work under high stress during inconvenient hours and may face situations where they need to operate on severely injured patients despite having limited surgical experience [4]. Consequently, the sustainability of trauma surgery as a field is at risk, as increasing numbers of surgical residents are hesitant to pursue it as a career path [5, 6].

Conversely, the traditional model for EGS care was based on an "on-call" system, where surgeons had to juggle EGS duties alongside their scheduled surgeries and clinic responsibilities. Delays in patient assessment were common, as the on-call surgeon might not be available onsite when consulted about an EGS patient. Moreover, many surgeons handle emergency surgery cases solely because of contractual obligations rather than specialization or interest [7]. With the adoption of the ACS model by having trauma surgeons cover EGS cases, there has been a notable improvement in patient outcomes and cost-effectiveness within North America [8, 9]. Moreover, studies indicate that this expanded scope for trauma surgeons has not compromised trauma patient outcomes and has supported viable and fulfilling professional careers for them [10].

Furthermore, given the current global instability and potential for military conflicts, a high-volume Level I trauma center operating under an ACS model is an ideal environment for offering dedicated educational opportunities and comprehensive trauma practices to military surgeons [11]. This also represents a clear advantage of the ACS model.

In 2008, Uranues et al. conducted a survey among experts from 27 European countries to assess their attitudes toward acute care surgery [12]. It highlighted the absence of a unified acute care surgery system across Europe, largely owing to diverse approaches and varying resources. Despite these challenges, a specific training program for the European Board of Emergency Surgery was eventually established [13]. A systematic review published in 2020 noted that ACS models are being implemented in the UK and Sweden [14]. Additionally, various ACS models have been described globally, including in several South American, Asian, and African countries, as well as in Australia [15–19]. In this review, Taiwan's ACS model is described as "a 24/7 in-house trauma surgeon who is not cleared from clinical duties covering all trauma and non-trauma surgical emergencies while also covering the emergency department" [14, 16, 20].

Trauma system in Taiwan

Before the 1990s, Taiwan, like many other countries, depended on general surgeons to manage severely injured patients. Surgeons were on-call and returned to the hospital only when assistance was requested by senior residents, a practice commonly referred to as the "on-call system." Trauma training for residents was conducted by various surgical subspecialties, as there was neither a dedicated trauma specialty nor so-called "trauma surgeons".

In response to several catastrophic natural and public safety disasters that resulted in significant casualties, the government-initiated reforms to enhance the national emergency medical system.

The key reforms emphasized the establishment of a national emergency medical service network. Since 2009, the Ministry of Health and Welfare has implemented a hospital emergency medical service capability grading system in accordance with the Emergency Medical Services Act. This system has established grading standards to assess hospitals' emergency response capabilities comprehensively and the quality of continuous care. Hospitals are classified on the basis of the types of emergency services they can provide, their personnel and facilities, and the quality of care rendered.

The classifications are as follows: "General Level" hospitals offer 24 h emergency services; "Intermediate Level" hospitals are equipped to manage stable trauma, acute strokes, acute coronary syndrome, high-risk pregnancies, and neonatal care while ensuring the proper arrangement of referrals and facilitating transfers from other hospitals for localized emergency services; and "Advanced Level" hospitals provide comprehensive treatment and care for critically ill patients, serving as definitive referral centers. Additionally, medical centers, per the guidelines for hospital accreditation, must also meet the criteria for "advanced level" hospitals.

In Taiwan, the accreditation process to assess each hospital's capability in managing trauma patients occurs every four years. To qualify as an "Advanced Level" trauma center, hospitals must have a well-organized trauma team staffed with qualified personnel who can respond to trauma calls at any time, perform emergency surgeries within 30 min when necessary, and carry out emergency arterial embolization as needed. Furthermore, hospitals must establish a review board for quality control and ongoing improvements in all aspects of trauma care. An "Advanced Level" trauma center should also

maintain a strong regional network with nearby "Intermediate Level" and "General Level" hospitals to facilitate efficient patient transfers.

Conversely, according to hospital accreditation guidelines, it is not mandatory for every hospital to adopt the ACS model of trauma surgery. While all medical centers are technically capable of meeting the "Advanced Level" requirements and fulfilling their responsibilities, many face challenges in recruiting qualified personnel in the trauma field. As a result, some may operate only at the minimum required level for trauma centers. In contrast, hospitals that implement the ACS model generally experience fewer issues in this regard.

Nonetheless, there are 23 medical centers (Fig. 1) and 51 hospitals with advanced emergency service capabilities in Taiwan. There is an average of one medical center for every million residents, and no location in Taiwan has more than a one-hour drive from the nearest advanced-level hospital. Even though it is believed that there is still room for improvement, statistical data from the Ministry of Health and Welfare indicate a consistent decline in accident-related mortality rates (Fig. 2).

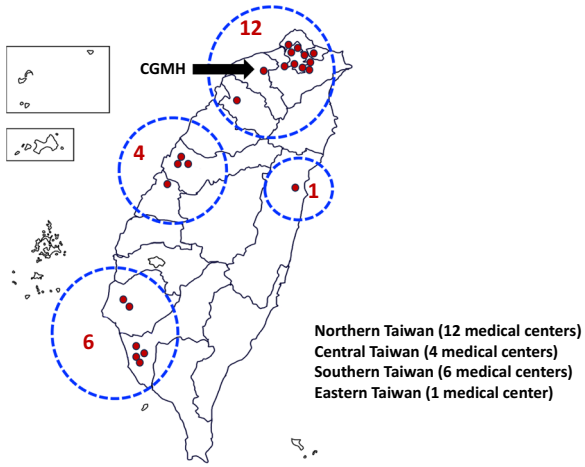

Fig. 1 Distribution of 23 medical centers in Taiwan. The arrow indicates the location of the authors' affiliation, Chang Gung Memorial Hospital (CGMH)

Trauma care in Taiwan

In Taiwan, there are currently 23 medical centers, each equipped with specialized trauma teams. Similar to experiences in other countries, the way these trauma teams operate varies due to differences in resources and personnel allocation across hospitals. Several models are described as follows:

1. *Exclusive Trauma focus*: Some trauma teams concentrate solely on the management of severe or multiple trauma patients, refraining from involvement in elective surgeries. This model is similar to that of the trauma center in South Korea.[21]
2. *Emergency department affiliation*: Certain trauma teams are integrated with the emergency department (ED) and tasked with conducting primary assessments and resuscitation of trauma patients. However, after the initial survey, trauma surgeons do not participate in ongoing patient care, with management

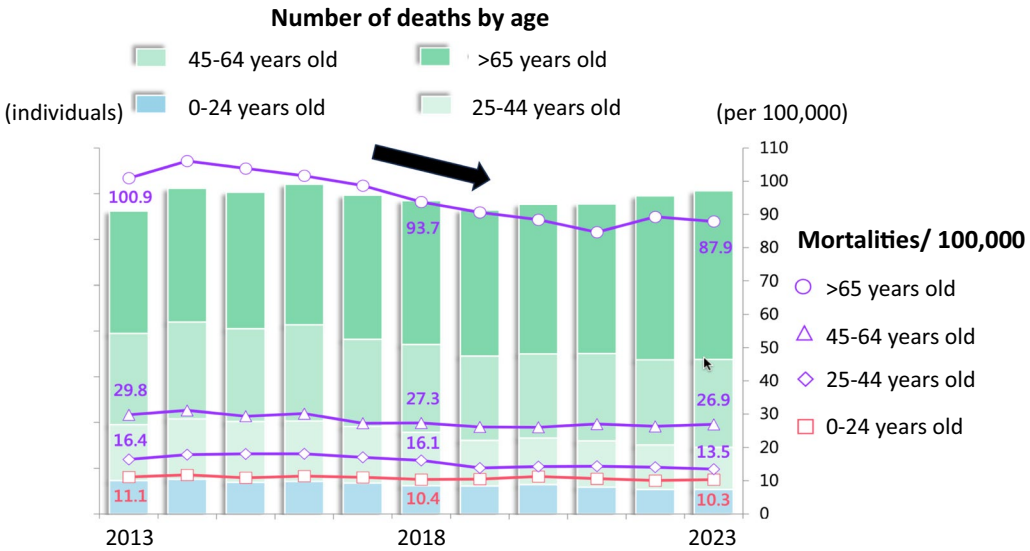

Fig. 2 Accident-related mortality rates over the past 10 years. According to the 2024 yearbook published by Taiwan's Ministry of Health and Welfare, there has been a consistent decline in accident-related mortality rates across all age groups

subsequently handing over to other surgical subspecialties.

3. *Collaboration with general surgery*: In some settings, in addition to treating trauma patients, trauma surgeons collaborate with general surgeons to manage patients requiring emergency general surgery (EGS) jointly.
4. *Comprehensive trauma responsibility*: A more integrated model allows the trauma team to assume comprehensive responsibility for all aspects of care related to both trauma patients and EGS patients admitted through the emergency department. This model encompasses primary assessment and resuscitation, management of hospitalized trauma patients, surgical interventions for visceral injuries and acute abdomen, elective surgeries, and surgical critical care. This approach resembles the ACS model that originated in North America but incorporates a broader range of services.

This comprehensive model, which integrates trauma, EGS, critical care, and patient care in the emergency department, can be referred to as an expanded ACS model. The Trauma Center at Chang Gung Memorial Hospital (CGMH) is one of the earliest adopters of this expanded ACS framework and has achieved remarkable success, establishing itself as a leading trauma center in Taiwan.

Acute care surgery in Taiwan

Before 1991, ED physicians at CGMH were responsible for conducting primary survey and providing initial resuscitation for all trauma and EGS patients. For the final disposition of these patients, the on-call surgeons—including general surgeons and other subspecialists—were consulted based on the specific organ-related issues identified by the ED physicians. In 1991, the CGMH trauma center was established and has since become a leader in trauma care in Taiwan, employing a comprehensive management approach to replace the previous model. This approach encompasses the full spectrum of care, from emergency admission to discharge, and is led by trauma surgeons who are board-certified specialists in the digestive system and trauma surgery.

At any given time, at least two trauma surgeons are on duty. One is responsible for initial assessments in the emergency department, while the other serves as the trauma team leader, coordinating with other surgical specialties to develop treatment plans for severely injured patients and perform surgeries for visceral organ injuries. In contrast, patients with isolated injuries, such as those involving the head or extremities, are typically referred to subspecialists like neurosurgeons or orthopedic surgeons after the trauma surgeons have completed the necessary evaluations. Additionally, trauma surgeons also take emergency general surgery calls and perform related emergency operations. For cases beyond the scope of the trauma surgeons' training—such as acute complications following liver transplantation—subspecialty surgeons can be consulted for definitive management.

Table 1 summarizes the annual number of trauma and EGS patients treated over the past five years. Briefly, we admitted over 4000 trauma patients through the emergency department each year, with approximately one-quarter of these patients presenting with an Injury Severity Score (ISS) ≥ 16. The trauma team performs around 3,000 surgeries annually, the majority being EGS procedures. Since most EGS cases are now managed by trauma surgeons rather than general surgeons, the training program for general surgical residents at CGMH has evolved. Today, residents receive EGS training during their trauma rotations while continuing their surgical oncology training in the general surgery department.

The trauma team also has a dedicated intensive care unit and general ward, with trauma surgeons assigned to care for the patients. On their off-duty days, trauma surgeons can perform elective surgeries. Importantly, trauma surgeons must rotate through the aforementioned roles. This means that a trauma surgeon may spend several months working in the emergency department, followed by a stint as the trauma team leader, and then focus on critical care for additional months. While the term "acute care surgery" was first introduced by the American Association for the Surgery of Trauma (AAST)

Table 1 Annual volume of trauma and emergency general surgery (EGS) patients at Chang Gung memorial hospital (CGMH) from 2019 to 2023

Year	2019	2020	2021	2022	2023
Number of ED trauma patients	26,261	23,014	20,677	21,341	24,349
Trauma team activation (n)	582	504	603	591	620
Trauma admissions (n)[#]	4429	4296	4293	4408	4712
Patients with ISS ≥ 16 (n)	1098	992	1067	1078	1185
Trauma-related surgeries (n)*	401	312	344	296	339
EGS admissions (n)	3407	2740	2808	2696	2783
EGS surgeries (n)	2904	2426	2504	2333	2516
Mortality rate for ISS ≥ 16	9.84%	9.98%	9.00%	10.76%	10.04%

ED: Emergency Department; ISS: Injury Severity Score

[#] Trauma admissions include patients with multiple injuries managed by trauma surgeons, as well as those with isolated injuries managed by subspecialty surgeons. All patients receive primary assessment by trauma surgeons at the ED prior to admission

[*] This category includes only surgeries performed by trauma surgeons. Surgeries performed by subspecialty surgeons such as neurosurgeons, orthopedic surgeons, and plastic surgeons are excluded

in 2003, the trauma team at CGMH has operated under this model since 1991.

The implementation of the ACS model has led to at least three significant improvements in patient care:

First, unlike ED physicians, trauma surgeons receive extensive training in surgical procedures. This enables them to act decisively in emergencies requiring procedures like cricothyroidotomy or resuscitative thoracotomy, thereby avoiding hesitation and saving valuable time in critical situations.

Second, in our ACS model, trauma surgeons are responsible for the primary assessment of all trauma patients upon arrival in the ED. This ensures smoother coordination with subspecialty surgeons and allows for effective decision-making on patient disposition without the delays associated with multiple consultations. As a result, we streamline the treatment process, significantly reducing patients' length of stay in the ED.

Third, with trauma surgeons always present in-house, all EGS patients can receive immediate and effective care. An experienced surgeon is readily available to handle critical cases and complex surgeries, which has markedly improved the quality of care for EGS patients.

Although the healthcare systems in Taiwan and the United States differ, the successful implementation of the ACS model at CGMH shows remarkable similarities to practices in the U.S. Both systems demonstrate that the ACS model is vital for the continuous advancement of trauma surgery and prevention of the shrinkage of trauma surgery [22]. The trauma center at CGMH has grown to be the largest and most comprehensive one in Taiwan, admitting more than 4000 trauma patients annually, more than 1200 of whom have an injury severity score (ISS) greater than 16.

Several key factors contribute to the successful implementation of the ACS model in Taiwan

First, the integration of EGS with trauma surgery is crucial to its success. Taiwan experiences a greater proportion of blunt trauma cases than the U.S., many of which can be managed nonoperatively. The ratio of trauma surgeries to emergency abdominal surgeries is approximately 1:8 in CGMH (Fig. 3). Therefore, if the practice scope of trauma surgeons is limited to treating only trauma patients, many may lose interest in trauma because of a lack of operative opportunities, prompting them to shift to other fields.

Second, as seen in U.S. practices, managing EGS concurrently does not compromise the quality of care for trauma patients. In fact, trauma surgeons can maintain their surgical skills by handling a significant number of EGS cases and accumulate invaluable experience in critical care, thereby increasing treatment quality [23].

Third, trauma surgeons rotate through various roles, including initial patient assessments in the emergency room, ward rounds, emergency operations, trauma/acute care surgery consultations, and critical care management. This comprehensive exposure familiarizes them with treatment protocols in every aspect, facilitating seamless communication and teamwork, which leads to more effective patient care.

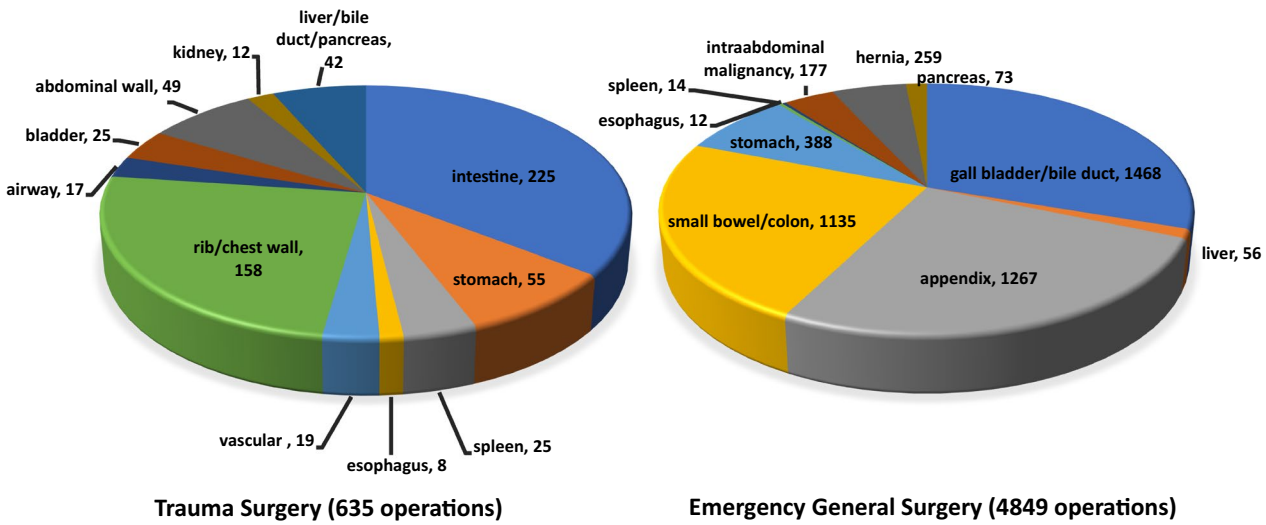

Fig. 3 The number of operations performed by the Chang Gung Memorial Hospital trauma team from 2022 to 2023. Since its establishment, the trauma team at Chang Gung Memorial Hospital has implemented the acute care surgery model. As illustrated in the figure, the volume of emergency general surgeries significantly exceeds that of trauma surgeries

Fourth, the ACS model not only broadens the scope of practice for trauma surgeons but also enhances their overall capabilities, offering significant flexibility in their career paths. Even if they choose to leave the trauma field, surgeons can transition smoothly into general surgery or critical care specialties [24, 25].

Finally, the advantages of the ACS model have made the trauma center at CGMH an attractive option for many young surgical residents. The continuous influx of passionate and talented newcomers creates a positive feedback loop, enabling the trauma team to achieve ongoing growth and development. By leveraging the benefits of the ACS model, the trauma team at CGMH has established itself as the premier trauma center in Taiwan.

Importantly, however, not all trauma centers in Taiwan can adopt the ACS model. Some hospitals opt to maintain traditional models to mitigate administrative risk, often due to limited financial resources. Others believe that establishing an ACS team is not economically viable because of insufficient patient volume [26]. Consequently, while the ACS model has succeeded in Taiwan, its implementation is limited to a limited number of trauma centers.

Conclusion

William S. Halsted is often quoted as saying, "Every important hospital should have, on its resident staff of surgeons, at least one who is well and able to deal with any emergency that may arise." This statement remains profoundly relevant even a century later. As medicine has been increasingly divided into various subspecialties, the need for a versatile physician capable of handling diverse emergencies is still essential for the care of critically ill patients. The emergence of the ACS model aims to reverse the decline in the trauma field that began in the 1980s. While no single system fits all, each adaptation of the original ACS model aims to address the unique challenges of each country and improve patient care. In Taiwan, we believe that this ACS model not only prevents the loss of talent but also helps maintain the professional skills of trauma surgeons, ensuring that trauma patients receive the highest quality of care [27].

Abbreviations

ACS	Acute care surgery
EGS	Emergency general surgery
CGMH	Chang Gung Memorial Hospital
AAST	American Association for the Surgery of Trauma

Author contributions

CHH, YTW, CHL, CTC and CYF collectively wrote the first draft. SCK, YPH, CPH, SAC, CAL, YHW, LWK, CCW, YST, FJH, CHOU, PHL, SYU reviewed all the operation records, summarized the type of trauma and EGS operations as well as preparing table and figures. CHH and YTW make the final review and revision of the manuscript.

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Declarations

Ethics approval and consent to participate

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Consent for publication

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Competing interests

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