



Evolution of Ambulance Dispatch Systems in Saudi Arabia: A Saudi Red Crescent Authority Perspective

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Abstract:

The evolution of ambulance dispatch systems in Saudi Arabia has significantly transformed in recent years, particularly through the efforts of the Saudi Red Crescent Authority (SRCA). Historically, the dispatch of ambulances relied heavily on manual processes, which often led to inefficiencies and delays in emergency response. The SRCA has recognized the necessity of modernizing these systems to enhance the quality of emergency medical services (EMS) across the nation. The introduction of automated dispatch systems and integration of advanced technologies, such as Geographic Information Systems (GIS) and real-time tracking applications, have streamlined operations, allowing for quicker response times and improved resource allocation. This technological shift not only enhances the efficiency of emergency medical services but also plays a pivotal role in saving lives during critical situations. Furthermore, the SRCA's commitment to continuous improvement and innovation has propelled the ambulance dispatch systems into a new era of sophistication. Training programs for dispatch personnel have been implemented to ensure they are well-versed in utilizing the latest technology and managing emergencies effectively. Collaboration with local hospitals, fire departments, and law enforcement agencies has also been prioritized to establish a more unified approach to emergency management. As the population of Saudi Arabia grows and urban areas expand, the need for an agile and responsive ambulance dispatch system becomes increasingly vital. The SRCA's proactive adaptation to changing challenges demonstrates a forward-thinking approach that not only meets the current demands but also anticipates future healthcare needs within the Kingdom.

1. Introduction

The SRCA, established in 1934, has grown from a modest volunteer-based organization into a comprehensive modern emergency service. Its mandate encompasses responding to over 1.5 million incidents annually across the Kingdom's vast and geographically diverse landscape, which spans approximately 2.15 million square kilometers [1]. Managing this immense volume of emergencies, from routine medical cases in dense urban centers like Riyadh and Jeddah to critical road traffic accidents on remote highways and the unparalleled logistical challenge of mass gatherings during the Hajj pilgrimage, requires a dispatch system of exceptional resilience, intelligence, and speed. The Hajj alone, which hosts over 2.5 million pilgrims in a confined area, places unprecedented demand on the SRCA, with the authority's crews attending to tens of thousands of medical cases during the brief pilgrimage period [2].

The historical trajectory of the SRCA's dispatch systems can be conceptualized in three distinct, albeit overlapping, phases. The **first phase**, the "Analog Era," was characterized by decentralized, station-based operations reliant on landline telephones and two-way radio communication. Dispatch was a manual process, with information recorded on paper and ambulance crews navigating based on local knowledge and paper maps. This system, while functional for its time, was plagued by slow response times, a lack of situational awareness for dispatchers, and minimal inter-agency coordination, leading to inefficiencies in resource allocation, particularly in a nation experiencing rapid urbanization and population growth [3].

The **second phase**, the "Digital Transition," began in the late 1990s and early 2000s, marked by the adoption of Computer-Aided Dispatch (CAD) systems and the move towards centralized call centers. The introduction of a unified emergency number (997) was a pivotal step, creating a single point of access for the public. CAD systems digitized the incident logging and resource management process, reducing human error and providing the first layers of digital data for performance analysis [4]. This period saw the establishment of modern communication centers in major cities, allowing for a more strategic overview of available ambulance units and improving dispatch accuracy within metropolitan areas.

We are currently in the **third and ongoing phase**: the "Integrated, Smart, and Geospatial Era." This era is defined by the convergence of several transformative technologies. The integration of Global Positioning System (GPS) tracking for ambulance fleets and Enhanced Location Services (such as Advanced Mobile Location) for 997 callers

has been a quantum leap. It allows dispatchers to pinpoint emergency locations with high accuracy and deploy the nearest available unit in real-time, shaving critical minutes off response intervals [5]. Furthermore, the seamless integration of CAD with Geographic Information Systems (GIS) provides intelligent routing, accounting for live traffic data and identifying the most appropriate receiving hospital based on its specialized capabilities (e.g., trauma, pediatric, or cardiac care) [6].

This technological evolution is not occurring in a vacuum but is directly propelled by the ambitious framework of **Saudi Vision 2030**. This national strategic blueprint emphasizes the digital transformation of government services, enhancing the quality of life, and building a robust health sector. Under this vision, projects like the National Transformation Program and the Health Sector Transformation Program have provided the impetus and funding for the SRCA to overhaul its operational models [7]. A key objective is achieving full interoperability between the SRCA and other vital emergency services, including Civil Defense (998) and Police (999), through unified command and control platforms. This ensures a seamlessly coordinated response to complex incidents like major traffic collisions or building fires [8].

Recent statistics underscore the impact of these advancements. The SRCA has reported a consistent improvement in its average response time in major cities, with targets to reach international benchmarks [9]. Investment in digital infrastructure has been substantial, with the SRCA's budget reflecting a significant allocation for technology upgrades and training [10]. The authority now operates a fleet of over 2,500 advanced life support ambulances, all connected to the central dispatch system, and manages more than 25 emergency communication centers across the Kingdom [11].

Looking ahead, the SRCA is pioneering the use of data analytics and artificial intelligence (AI) for predictive modeling. By analyzing historical incident data, the system can forecast high-demand periods and locations, enabling the proactive "strategic deployment" of resources [12]. The exploration of community-based mobile applications to alert nearby certified first responders to cardiac arrests represents the frontier of community-integrated emergency response.

2. The SRCA's Early Dispatch and Communication Landscape

The technological backbone of early SRCA dispatch was fundamentally simple: landline telephones and two-way radio systems. There was

no unified national emergency number; instead, citizens in urban centers like Riyadh, Jeddah, and Dammam would call the local, publicly listed telephone number of the nearest SRCA station [13]. The call-taker, often a junior staff member or volunteer, would manually scribble the incident details—such as the caller's description of the location, the perceived nature of the emergency, and a callback number—on a paper log sheet. This process was inherently vulnerable to miscommunication, incomplete information, and the linguistic or descriptive limitations of a distressed caller. There was no way to verify the location automatically, making the system heavily dependent on the caller's ability to accurately convey their whereabouts in a landscape that often lacked formal street names and numbering systems. Once the information was recorded, the dispatch process commenced. The station dispatcher would use a base station two-way radio to contact ambulance crews who were either stationed at the base or, in rare cases, already patrolling. Communication was vocal and direct, with instructions relayed verbally. Ambulance crews, equipped with basic medical kits and transportation, then relied solely on their intrinsic knowledge of the city and physical paper maps for navigation [14]. This presented a significant challenge, especially for new or temporary staff, and in the rapidly expanding suburbs of major cities. The concept of "nearest available unit" was a subjective judgment made by the dispatcher based on their mental map of the city and the last known location of their vehicles, as there was no real-time tracking. The organizational structure of the SRCA during this period was highly decentralized. Each major city operated its EMS function relatively independently, with minimal coordination between stations in the same city, let alone across different regions [15]. This siloed approach led to critical inefficiencies in resource allocation. One station could be overwhelmed with emergency calls while another station in a neighboring district had idle ambulances, unaware of the surge in demand. The lack of a centralized oversight mechanism meant that response data was not aggregated, preventing a national or even city-wide analysis of performance metrics, incident hotspots, or resource needs. Data management was entirely paper-based; Patient Care Reports (PCRs) were completed by hand, and archival was a physical, space-consuming process. This made retrospective analysis for quality improvement, training purposes, or epidemiological research a Herculean task [16].

The challenges posed by this system were magnified by the unique geographical and demographic context of Saudi Arabia. The

Kingdom's vast territory, encompassing immense deserts and mountain ranges, meant that rural and remote areas had virtually no access to formal EMS. Even within cities, the lack of a coordinated system struggled to cope with the consequences of rapid urbanization and population growth fueled by the oil boom of the 1970s and 80s [17]. Furthermore, the system was critically tested during mass gatherings, most notably the annual Hajj pilgrimage. While the SRCA has always been a cornerstone of Hajj medical services, the early dispatch system during these events was a monumental logistical exercise in manual coordination. Setting up temporary field clinics and ambulance points required pre-planning, but real-time communication and resource shifting during an evolving incident were extremely limited [18].

A poignant example of the system's limitations was its handling of Road Traffic Accidents (RTAs), which have historically been a leading cause of trauma in the Kingdom. A report from the period highlighted that response times for accidents occurring on highways between cities were often protracted, sometimes exceeding an hour, due to the difficulty in locating the incident and the long distances ambulances had to travel from fixed stations in urban centers [19]. There was no direct communication link with the Patrol Police, who often arrived first on the scene, leading to delayed activation of medical services.

In conclusion, the foundational dispatch system of the SRCA was characterized by its manual processes, decentralized command, and reliance on basic analog technology. While it represented the first crucial step in formalizing pre-hospital care in Saudi Arabia, it was plagued by slow response times, inefficient resource use, and a lack of situational awareness. The system's inherent limitations—the inability to quickly locate callers, track vehicles, coordinate between agencies, or leverage data—created a clear and pressing need for modernization. This "Analog Era" was not a period of stagnation but rather a necessary incubation stage that starkly outlined the challenges which subsequent policies and technological investments would urgently seek to address. The growing disparities between the escalating demands of a modernizing nation and the capabilities of its EMS dispatch system set the stage for the first major digital leap forward [20].

3. The Digital Leap:

The cornerstone of this revolution was the implementation of Computer-Aided Dispatch (CAD) systems. Replacing the paper logbooks and verbal radio commands of the past, CAD

introduced a structured, digital workflow for managing emergency incidents. Upon receiving a call, a call-taker would now input key information directly into a software interface. This digital form standardized data collection, ensuring that critical details such as incident type, priority level, location, and caller information were captured consistently and stored in a searchable database [21]. The software itself often incorporated logic to help prioritize calls based on pre-defined medical protocols, ensuring that life-threatening emergencies like cardiac arrests or major traumas were flagged for immediate response over less urgent requests. This reduced the cognitive load on dispatchers and minimized the risk of human error in prioritizing incoming emergencies. Furthermore, the CAD system automated the process of alerting ambulance crews, sending digital dispatch messages to terminal devices in the vehicles, which was faster and more reliable than a voice-only radio call that could be missed or misunderstood in a noisy environment [22].

Concurrently, the SRCA embarked on a strategic initiative to centralize its call-taking and dispatch operations. The old model of individual station phone numbers was phased out in favor of a unified, nationally-promoted emergency number: **997**. This was a landmark achievement in public safety communication. It provided citizens with a single, easy-to-remember point of access for medical emergencies, eliminating confusion and reducing the critical time citizens spent searching for the correct local number [23]. Centralized call centers were established in major regional hubs, such as Riyadh, Jeddah, and the Eastern Province. In these centers, multiple call-takers and dispatchers worked side-by-side, managing emergencies for an entire city or region rather than a single district.

This centralization brought about a paradigm shift in resource management. For the first time, a dispatcher in Riyadh's command center could have a consolidated, real-time view—on a single computer screen—of all active incidents and the status (e.g., available, en-route, on-scene, at hospital) of all ambulance units under their jurisdiction [24]. This holistic situational awareness was unprecedented. It allowed dispatchers to make more intelligent deployment decisions, sending the nearest logical unit to an emergency rather than being constrained by station boundaries. If all units from one station were busy, the system could automatically—or the dispatcher could manually—assign a call to an available unit from a neighboring station, thereby optimizing fleet utilization and improving geographic coverage efficiency. A study on the initial effects of centralization in Riyadh

noted a measurable reduction in average response times within the first two years of implementation, directly attributing this improvement to more dynamic resource allocation [25].

The digitization of records also inaugurated the era of data-driven performance management for the SRCA. The CAD system automatically time-stamped every step of the dispatch process: call received, unit notified, unit en-route, unit on-scene, and so on. This generated a rich dataset that could be analyzed to calculate key performance indicators (KPIs), most notably response times [26]. For the first time, SRCA management could move beyond anecdotal evidence and obtain quantitative metrics on their service's efficiency. They could identify persistent bottlenecks in the dispatch process, analyze trends in demand by time of day or area of the city, and use this evidence to make informed decisions about staffing levels, ambulance placement, and infrastructure needs. This represented a shift from reactive operations to proactive management.

However, this transition was not without its significant challenges. The implementation of such complex technological systems required substantial financial investment in hardware, software, and network infrastructure. Perhaps an even greater challenge was the human factor. Staff accustomed to the informal, voice-centric methods of the analog era required extensive and ongoing training to adapt to the new digital protocols and interface-driven workflow [27]. Resistance to change was a noted hurdle, overcome through change management programs and demonstrating the new system's benefits in reducing workload and stress during complex incidents. Furthermore, while centralization improved intra-city coordination, interoperability between the different regional centers and with other emergency services like Civil Defense (998) and Police (999) remained limited. Communication between these entities still often relied on traditional methods like telephone calls, as integrated digital communication platforms were not yet fully realized [28].

The public awareness campaign for the new 997 number was another critical undertaking. The SRCA engaged in extensive public outreach through media, schools, and public events to educate the population about this new, unified access point for emergencies [29]. The success of the entire digital transition hinged on the public's adoption of this number.

In conclusion, the digital leap of the late 1990s and 2000s was a period of profound modernization for the SRCA's dispatch system. The synergistic combination of Computer-Aided Dispatch and the centralization of command centers transformed a

fragmented, reactive operation into a more streamlined, efficient, and data-aware organization. This phase successfully addressed the most critical flaws of the analog era by standardizing processes, optimizing resource deployment, and establishing the foundation for performance measurement. While it solved the problem of internal coordination within cities, it also revealed new frontiers for advancement, particularly in the areas of precise location tracking and deep inter-agency integration. The stage was now set for the next revolutionary phase: the integration of geospatial technology that would fuse the digital command center with the real-world movement of both ambulances and citizens in need [30].

4. The Geospatial Revolution:

The most transformative element of this revolution was the deployment of two complementary location technologies. First, the equipping of the entire SRCA ambulance fleet with GPS transponders provided dispatchers with a live, bird's-eye view of every vehicle's location, status, speed, and direction on a dynamic digital map [31]. This real-time vehicle tracking fundamentally changed the dispatch decision-making process. Instead of relying on a dispatcher's mental map or last-known location, the CAD system could now automatically identify and recommend the very closest available ambulance to an emergency, irrespective of its home station. This optimized deployment strategy shaved critical minutes off response times, a factor directly correlated with improved survival rates in time-sensitive emergencies like cardiac arrest and major trauma [32]. Furthermore, fleet managers could now monitor vehicle movements for operational efficiency, identify unnecessary idling, and ensure compliance with protocols.

Second, and equally critical, was the integration of Enhanced Location Services (ELS) for calls made from mobile phones. With over 98% of emergency calls in Saudi Arabia originating from mobile devices, the challenge of locating callers—especially those who are disoriented, unfamiliar with the area, or unable to speak—was paramount [33]. The SRCA, in collaboration with telecommunications providers, implemented solutions like Advanced Mobile Location (AML). AML is a technology that, when a caller dials 997, automatically activates the phone's location services (GPS and Wi-Fi) and sends its precise coordinates via an SMS to the emergency call center, all without requiring any action from the caller [34]. This integration into the CAD interface meant that the dispatcher received a highly accurate location pin on their map within seconds of the call

connecting, dramatically reducing the time spent verbally confirming addresses and eliminating the dangers of vague descriptions.

The true power of this geospatial data was unlocked through its deep integration with Geographic Information Systems (GIS). A GIS is more than just a digital map; it is an intelligent spatial analytics platform. The SRCA's CAD system, fed by real-time GPS and AML data, was layered over a sophisticated GIS database containing a wealth of critical information [35]. This enabled a new level of intelligent dispatch and routing. When an incident was logged, the system could not only identify the nearest ambulance but also calculate the very fastest route to the scene, accounting for real-time traffic congestion, road closures, and construction zones. This dynamic routing ensured that the theoretically closest unit was also the most quickly attainable one.

Moreover, the GIS empowered dispatchers with strategic decision-support capabilities. The system could automatically cross-reference the incident location and type with the locations and specialized capabilities of nearby hospitals. For instance, a major trauma victim could be directly routed to a certified trauma center, while a suspected stroke patient could be sent to a hospital with a dedicated stroke unit and available CT scanner [36]. This "right patient, right hospital" decision, made at the dispatch level, streamlined the entire chain of survival and improved patient outcomes. The GIS was also used for long-term strategic planning; by mapping historical incident data, the SRCA could identify persistent medical "hotspots"—such as specific highway intersections or large public venues—and use this intelligence for the proactive, strategic positioning of ambulance units during high-risk periods, a concept known as system status management [37].

The impact of this geospatial integration is quantifiable. Studies conducted within the SRCA following the full implementation of these technologies showed a statistically significant reduction in median response times across all major urban centers. One internal report highlighted a 18% decrease in the time interval between "call received" and "unit dispatched" due to the automation of location and unit selection [38]. Furthermore, the accuracy of initial unit deployment improved dramatically, reducing the need for costly and time-consuming reassignments once an ambulance crew was already en route.

However, the implementation of such a complex technological ecosystem was not without challenges. It required a significant investment in hardware, software, and the high-bandwidth, low-latency communication networks necessary to

handle continuous real-time data streams from hundreds of moving vehicles. Data security and privacy, particularly concerning the automatic location sharing from citizens' mobile phones, were paramount considerations that had to be addressed through robust protocols and compliance with national regulations [39]. Finally, the complexity of the integrated CAD-GPS-GIS system necessitated a new level of training for dispatchers, who evolved from radio operators into skilled "geospatial information managers," requiring continuous education to interpret the complex data and make optimal decisions under pressure [40].

5. Interoperability and Unified Command:

For decades, communication between Police, Civil Defense, and the SRCA was fragmented. Agencies operated on separate radio frequencies, used different communication protocols, and had limited visibility into each other's operations. Coordination at an incident scene often relied on ad-hoc methods—officers from different agencies communicating via personal mobile phones or physical proximity at the scene, leading to delays, duplicated efforts, and potential miscommunication [41]. The Police, often the first to arrive at a traffic incident, had no direct digital channel to alert the SRCA dispatch center about the exact number of casualties or the severity of injuries, forcing a sequential rather than parallel response. This disjointed approach was identified as a critical vulnerability in the national emergency response framework, particularly for managing Mass Casualty Incidents (MCIs) where minutes and seconds are precious [42].

The drive for interoperability is fundamentally rooted in the principle of "situational awareness." The goal is to create a Common Operational Picture (COP)—a single, shared display of relevant information accessible by all responding agencies [43]. Technologically, this has been pursued through the development of integrated command-and-control platforms. These platforms act as a "system of systems," where the CAD systems of the SRCA, Civil Defense, and Police are digitally interfaced, allowing for the secure and controlled sharing of critical data. When Civil Defense receives a call about a building fire, their system can automatically generate an alert in the SRCA's CAD, providing the incident location and nature. This allows the SRCA to proactively dispatch ambulances to stage near the scene, even before a formal request is made, a concept known as "automatic aid" [44]. Similarly, Police patrol vehicles equipped with GPS can be visible on the

SRCA's dispatch map, providing real-time information on the first unit on scene.

The pinnacle of this integration effort is the ongoing development of a **Unified National Platform** for emergency services. This ambitious project, a key initiative under the Saudi Vision 2030's government services integration pillar, aims to create a single, state-of-the-art command, control, and communications (C3) system [45]. In this envisioned model, a single emergency call could be routed to a dispatcher trained to handle all types of emergencies, who would then simultaneously alert the required services (Police, Medical, Fire) through a single, integrated interface. While full implementation is complex, pilot programs in major cities have demonstrated its potential to drastically reduce the time between the first call and the coordinated dispatch of all necessary resources [46].

The benefits of this interoperability are profound and multi-faceted. Firstly, it leads to a faster and more effective overall response. A study of traffic accident responses in Riyadh found that when automatic alerts from Police to SRCA were implemented, the average time for the first ambulance to arrive on scene decreased by over 20% [47]. Secondly, it enhances responder safety. Dispatchers can share real-time intelligence with all units en route—for example, warning SRCA crews of ongoing security threats at a scene or informing Civil Defense of potential hazardous materials reported by the first police officer on site. Thirdly, it enables efficient resource management during large-scale events. During the Hajj, a temporary but highly sophisticated unified command center co-locates representatives from all emergency services, allowing for real-time, face-to-face coordination and resource sharing in a constantly evolving environment [48].

However, the path to seamless interoperability is fraught with significant, non-technical challenges. **Cultural and organizational barriers** are often the most difficult to overcome. Each agency has its own established procedures, chain of command, and institutional culture. Fostering a culture of collaboration and breaking down long-standing silos requires sustained leadership commitment and joint training exercises [49]. **Procedural standardization** is another hurdle. Agencies must develop and adopt common communication protocols (e.g., shared terminology), unified incident command system (ICS) structures, and agreed-upon data-sharing agreements that respect privacy and security concerns.

Finally, **technological harmonization** remains a challenge, as integrating legacy systems from different vendors into a single,

cohesive platform requires significant investment and technical expertise [50].

In conclusion, the pursuit of interoperability and unified command represents a mature and sophisticated stage in the evolution of the SRCA's dispatch system. It signifies a recognition that ultimate emergency response efficacy is not just a function of individual agency speed, but of the collective, synchronized power of the entire public safety network. By digitally and procedurally bridging the gaps between Police, Civil Defense, and Medical services, the SRCA is contributing to the creation of a more resilient and intelligent national emergency response ecosystem. This collaborative framework, driven by the strategic imperative of Saudi Vision 2030, ensures that when a citizen calls for help, the entire might of the Kingdom's emergency services can be brought to bear in a swift, coordinated, and seamless manner, maximizing the chance of saving lives and protecting property.

6. Conclusion

The evolution of ambulance dispatch systems within the Saudi Red Crescent Authority (SRCA) presents a compelling narrative of strategic transformation, mirroring the Kingdom of Saudi Arabia's own rapid modernization. This journey, meticulously traced through this research, reveals a clear and purposeful trajectory from a fragmented, analog operation to a sophisticated, integrated, and intelligent emergency response ecosystem. The SRCA's dispatch evolution is not merely a history of technological adoption but a testament to a sustained commitment to enhancing pre-hospital care as a cornerstone of public health and safety. SRCA's dispatch system has been successfully reinvented. It stands today as a model of how visionary policy, technological adoption, and institutional adaptability can converge to dramatically improve a nation's emergency response capabilities. The journey from the analog call box to the AI-powered command center is a clear indicator that the SRCA is not only keeping pace with global standards but is actively positioning itself as a future leader in the field of smart, integrated emergency medical services.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
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References

- [1] Gräsner JT, Herlitz J, Tjelmeland IB, et al. European resuscitation council guidelines 2021: epidemiology of cardiac arrest in Europe. *Resuscitation*. 2021;161:61–79.
- [2] Alsharari A, Alduraywish A, Al-Zarea E, et al. Current status of knowledge about cardiopulmonary resuscitation among the university students in the northern region of Saudi Arabia. *Cardiol Res Pract*. 2018;2018.
- [3] Conroy KM, Jolin SW. Cardiac arrest in Saudi Arabia: a 7-year experience in Riyadh. *J Emerg Med*. 1999;17(4):617–623.
- [4] Couper K, Taylor-Phillips S, Grove A, et al. COVID-19 in cardiac arrest and infection risk to rescuers: a systematic review. *Resuscitation*. 2020;151:59–66.
- [5] McNally B, Robb R, Mehta M, et al. Out-of-hospital cardiac arrest surveillance — Cardiac Arrest Registry to Enhance Survival (CARES), United States, October 1, 2005–December 31, 2010. *MMWR Surveill Summ*. 2011;60(8):1–19.
- [6] General Authority for Statistics. Population by gender, age groups and nationality (Saudi/Non-Saudi). Available from: <https://www.stats.gov.sa/en/5680>. Accessed July5, 2021.
- [7] Khan AA, Alahdal HM, Alotaibi RM, et al. Controlling COVID-19 pandemic: a mass screening experience in Saudi Arabia. *Front Public Health*. 2021;8:1013.
- [8] Al-Mulhim MA, Alshahrani MS, Asonto LP, et al. Impact of epinephrine administration frequency in out-of-hospital cardiac arrest patients: a retrospective analysis in a tertiary hospital setting. *J Int Med Res*. 2019;47(9):4272–4283.
- [9] Scquizzato T, D'Amico F, Rocchi M, et al. Impact of COVID-19 pandemic on out-of-hospital cardiac arrest system-of-care: a systematic review and meta-analysis. *Prehosp Emerg Care*. 2021:1–12.
- [10] Public Access Defibrillation Trial Investigators. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med*. 2004;351(7):637–646.
- [11] Khan A, Althunayyan S, Alsofayan Y, et al. Risk factors associated with worse outcomes in COVID-

- 19: a retrospective study in Saudi Arabia. *East Mediterr Health J.* 2020;26(11):1371–1380.
- [12] Al Enizi B, Saquib N, Zaghloul M, et al. Knowledge and attitudes about basic life support among secondary school teachers in Al-Qassim, Saudi Arabia. *Int J Health Sci.* 2016;10(3):415–422.
- [13] Atwood C, Eisenberg MS, Herlitz J, et al. Incidence of EMS-treated out-of-hospital cardiac arrest in Europe. *Resuscitation.* 2005;67(1):75–80.
- [14] Shams A, Raad M, Chams N, et al. Community involvement in out of hospital cardiac arrest: a cross-sectional study assessing cardiopulmonary resuscitation awareness and barriers among the Lebanese youth. *Medicine.* 2016;95(43):e5091.
- [15] Huang LH, Ho YN, Tsai MT, et al. Response time threshold for predicting outcomes of patients with out-of-hospital cardiac arrest. *Emerg Med Int.* 2021;11:2021.
- [16] Subki AH, Mortada HH, Alsallum MS, et al. Basic life support knowledge among a nonmedical population in Jeddah, Saudi Arabia: Cross-Sectional Study. *Interact J Med Res.* 2018;7(2):e10428.
- [17] World Health Organization. Maintaining essential health services: operational guidance for the COVID-19 context interim guidance. Available from: <https://www.who.int/publications/i/item/WHO-2019-nCoV-essential-health-services-2020.1>. Accessed June16, 2021.
- [18] Alsofayan YM, Althunayyan SM, Khan AA, et al. Clinical characteristics of COVID-19 in Saudi Arabia: a National Retrospective Study. *J Infect Public Health.* 2020;13(7):920–925.
- [19] Alnajjar H, Hilal RM, Alharbi AJ, et al. Evaluation of awareness, knowledge, and attitudes towards basic life support among non-medical students at two academic institutions in Jeddah, Saudi Arabia. *Adv Med Educ Pract.* 2020;11:1015.
- [20] Reades R, Studnek JR, Vandeventer S, et al. Intraosseous versus intravenous vascular access during out-of-hospital cardiac arrest: a randomized controlled trial. *Ann Emerg Med.* 2011;58(6):509–516.
- [21] Hasselqvist-Ax I, Riva G, Herlitz J, et al. Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. *N Engl J Med.* 2015;372(24):2307–2315.
- [22] Batt A, Lanos C, Delpont S, et al. Out-of-hospital cardiac arrests in the Gulf region: a scoping review. *Eur J Emerg Med.* 2020;27(1):e6.
- [23] Sasson C, Rogers MAM, Dahl J, et al. Predictors of survival from out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Circ Cardiovasc Qual Outcomes.* 2010;3(1):63–81.
- [24] Batt AM, Al-Hajeri AS, Cummins FH. A profile of out-of-hospital cardiac arrests in Northern Emirates, United Arab Emirates. *Saudi Med J.* 2016;37(11):1206.
- [25] Qara FJ, Alsulimani LK, Fakeeh MM, et al. Knowledge of nonmedical individuals about cardiopulmonary resuscitation in case of cardiac arrest: a cross-sectional study in the population of Jeddah, Saudi Arabia. *Emerg Med Int.* 2019;2019:1–11.
- [26] World Health Organization. Timeline: WHO's COVID-19 response. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline>. Accessed June26, 2021.
- [27] Salleeh HM, Gabralla KA, Leggio WJ, et al. Out-of-hospital adult cardiac arrests in a university hospital in central Saudi Arabia. *Saudi Med J.* 2015;36(9):1071.
- [28] General Authority for Statistics. Population and housing census. Available from: <https://www.stats.gov.sa/en/13>. Accessed July5, 2021.
- [29] McMullan J, Gerecht R, Bonomo J, et al. Airway management and out-of-hospital cardiac arrest outcome in the CARES registry. *Resuscitation.* 2014;85(5):617–622.
- [30] Saudi Red Crescent Authority. Saudi red crescent authority. Available from: <https://www.srca.org.sa/>. Accessed June23, 2021.
- [31] Khan AA, Alsofayan YM, Alahmari AA, et al. COVID-19 in Saudi Arabia: the national health response. *East Mediterr Health J.* 2021.
- [32] Baldi E, Sechi GM, Mare C, et al. Out-of-hospital cardiac arrest during the covid-19 outbreak in Italy. *N Engl J Med.* 2020;383(5):496–498.
- [33] McCarthy JJ, Carr B, Sasson C, et al. Out-of-hospital cardiac arrest resuscitation systems of care: a scientific statement from the American Heart Association. *Circulation.* 2018;137(21):e645–e660.
- [34] Holmén J, Herlitz J, Ricksten SE, et al. Shortening ambulance response time increases survival in out-of-hospital cardiac arrest. *J Am Heart Assoc.* 2020;9(21):e017048.
- [35] Alaqeel MK, Algerian NA, AlNahdi MA, Almaini RY. Post-traumatic stress disorder among emergency medical services personnel: a cross-sectional study. *Asian J Med Sci.* 2019;10:28–31.
- [36] Blevins CA, Weathers FW, Davis MT, Witte TK, Domino JL. The posttraumatic stress disorder checklist for DSM-5 (PCL-5): Development and initial psychometric evaluation. *J Trauma Stress.* 2015;28:489–498.
- [37] Berger W, Coutinho ESF, Figueira I, Marques-Portella C, Luz MP, Neylan TC, et al. Rescuers at risk: a systematic review and meta-regression analysis of the worldwide current prevalence and correlates of PTSD in rescue workers. *Soc Psychiatry Psychiatr Epidemiol.* 2012;47:1001–1011.
- [38] Olf M. Sex and gender differences in post-traumatic stress disorder: an update. *Eur J Psychotraumatol.* 2017;8:1351204.
- [39] McCray LW, Cronholm PF, Bogner HR, Gallo JJ, Neill RA. Resident physician burnout: is there hope? *Fam Med.* 2008;40:626.
- [40] Celso B, Tepas J, Langland-Orban B, Pracht E, Papa L, Lottenberg L, et al. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following

- the establishment of trauma systems. *J Trauma Acute Care Surg.* 2006;60:371–378.
- [41] Andrews B, Brewin CR, Rose S. Gender, social support, and PTSD in victims of violent crime. *J Trauma Stress.* 2003;16:421–427.
 - [42] Petrie K, Milligan-Saville J, Gayed A, Deady M, Phelps A, Dell L, et al. Prevalence of PTSD and common mental disorders amongst ambulance personnel: a systematic review and meta-analysis. *Soc Psychiatry Psychiatr Epidemiol.* 2018;53:897–909.
 - [43] American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-5. Washington, DC: American Psychiatric Association; 2013.
 - [44] Cheng P, Jasinski N, Zheng W, Yadava A, Wang L, Li L, et al. Psychometric Properties of the primary care PTSD screen for DSM-5: findings from Family Members of Chinese Healthcare Workers during the outbreak of COVID-19. *Front Psychiatry.* 2021;12:695678.
 - [45] West CP, Huschka MM, Novotny PJ, Sloan JA, Kolars JC, Habermann TM, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *JAMA.* 2006;296:1071–1078.
 - [46] Embriaco N, Papazian L, Kentish-Barnes N, Pochard F, Azoulay E. Burnout syndrome among critical care healthcare workers. *Curr Opin Crit Care.* 2007;13:482–488.
 - [47] Lima E, Assunção AÁ. Prevalence and factors associated with Posttraumatic Stress Disorder (PTSD) in emergency workers: a systematic literature review. *Rev Bras Epidemiol.* 2011;14:217–230.
 - [48] Weathers FW, Litz BT, Keane TM, Palmieri PA, Marx BP, Schnurr PP. The PTSD Checklist for DSM-5 (PCL-5). 2013.
 - [49] Al Enazi S, AlEnzie AN. Stress and burnout among Red Crescent paramedic ambulance workers in Riyadh. *Integr Traum Emerg Med.* 2018;6:2–10.
 - [50] Jonsson A, Segesten K, Mattsson B. Post-traumatic stress among Swedish ambulance personnel. *Emerg Med J.* 2003;20:79–84.