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The Impact of Advanced Life Support on Clinical Outcomes in Saudi Red Crescent Authority Ambulance Services

أثر خدمات دعم الحياة المتقدم على النتائج السريرية في خدمات سيارات الإسعاف التابعة لهيئة الهلال الأحمر السعودي

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Abstract:

Background: Advanced life support (ALS) adds advanced airway, vascular, monitoring, and pharmacological capabilities to basic life support (BLS), but the incremental effect of those capabilities on patient-centered outcomes in Saudi Red Crescent Authority (SRCA) ambulance care is uncertain.
Objective: To critically synthesize published SRCA and relevant Saudi prehospital evidence on ALS procedures, out-of-hospital cardiac arrest (OHCA), survival, return of spontaneous circulation (ROSC), trauma outcomes, and delivery-system determinants.
Methods: The previously drafted review was reappraised against primary reports accessible through PubMed/PMC and publisher records. Eleven verifiable original studies published during 2021–2025 were characterized in a structured evidence map, stratified by direct SRCA clinical evidence, SRCA operational evidence, and indirect Saudi contextual evidence. Two post–March 2025 reports were marked as updates. This is a transparent structured review rather than a claimed fully reproducible PRISMA systematic search: the original screening log and database-specific record counts were unavailable. Narrative synthesis was used; no pooled ALS-versus-BLS estimate was attempted.
Results: Among 1,307 SRCA OHCA cases, 329 (25.2%) were attended by ALS units and 978 (74.8%) by BLS units; 102 (7.8%) achieved prehospital ROSC [1]. The SOHAR registry recorded 275/3,671 (reported as 7.4%) with prehospital ROSC and 107/3,671 (2.9%) discharged alive [2]. A subsequent 6,012-case SRCA OHCA analysis reported ROSC in 760 (12.6%) and an adjusted association between mechanical CPR use and ROSC (adjusted OR 1.433; 95% CI 1.202–1.709), but did not establish a causal benefit attributable to ALS dispatch as a bundle [5]. Across the 11 reports, heterogeneous populations, exposure definitions, and endpoints precluded a credible pooled ALS effect.
Conclusions: Published Saudi research describes ALS-capable SRCA practice and clinically important gaps in cardiac arrest survival, dispatch, transport and trauma triage. It does not establish that ALS, compared with otherwise timely and high-quality BLS, independently improves survival or neurological recovery. A definitive SRCA effectiveness review requires a reproducible search, complete screening records, risk-of-bias judgments and adjusted, patient-linked comparative data.

Keywords: advanced life support; Saudi Red Crescent Authority; ambulance; basic life support; out-of-hospital cardiac arrest; resuscitation; trauma; clinical outcomes; evidence synthesis.

الملخص

الخلفية :تضيف خدمات دعم الحياة المتقدم (ALS) إلى خدمات دعم الحياة الأساسي (BLS) إمكانات متقدمة في تأمين مجرى الهواء، والوصول الوعائي، والمراقبة، والتدخلات الدوائية. ومع ذلك، لا يزال الأثر الإضافي لهذه الإمكانات على النتائج الصحية التي تهم المرضى ضمن خدمات سيارات الإسعاف التابعة لهيئة الهلال الأحمر السعودي (SRCA) غير واضح.
الهدف :التوليف النقدي للأدلة المنشورة المتعلقة بهيئة الهلال الأحمر السعودي والأدلة السعودية ذات الصلة بمرحلة ما قبل المستشفى، بشأن إجراءات دعم الحياة المتقدم، والتوقف القلبي خارج المستشفى(OHCA) ، والبقاء على قيد الحياة، وعودة الدورة الدموية التلقائية(ROSC) ، ونتائج حالات الإصابات، والعوامل المحددة لأداء منظومة تقديم الخدمات.
المنهجية :أُعيد تقييم المراجعة التي أُعدت سابقًا في ضوء التقارير الأصلية المتاحة عبر قواعد بيانات PubMed/PMC وسجلات الناشرين. وصُنفت إحدى عشرة دراسة أصلية قابلة للتحقق، نُشرت خلال الفترة 2021–2025، ضمن خريطة أدلة منظمة، وفق ثلاثة محاور: الأدلة السريرية المباشرة المتعلقة بهيئة الهلال الأحمر السعودي، والأدلة التشغيلية الخاصة بالهيئة، والأدلة السياقية السعودية غير المباشرة. كما جرى تحديد تقريرين نُشرا بعد مارس 2025 بوصفهما تحديثين. وتمثل هذه الدراسة مراجعة منظمة وشفافة، ولا تدّعي أنها مراجعة منهجية وفق بروتوكول PRISMA قابل للتكرار بالكامل؛ إذ لم تكن سجلات الفرز الأصلية وأعداد الدراسات المسترجعة من كل قاعدة بيانات متاحة. واستُخدم التوليف السردي، دون محاولة احتساب تقدير مجمع للمقارنة بين دعم الحياة المتقدم ودعم الحياة الأساسي.
النتائج :من بين 1,307 حالات توقف قلبي خارج المستشفى تابعة لهيئة الهلال الأحمر السعودي، استجابت وحدات دعم الحياة المتقدم لـ329 حالة (25.2%)، في حين استجابت وحدات دعم الحياة الأساسي لـ978 حالة (74.8%)، وحققت 102 حالة (7.8%) عودة الدورة الدموية التلقائية في مرحلة ما قبل المستشفى [1]. وسجلت قاعدة بيانات SOHAR عدد 275 حالة من أصل 3,671

(بنسبة مُبلّغ عنها بلغت 7.4%) حققت عودة الدورة الدموية التلقائية قبل الوصول إلى المستشفى، بينما خرج 107 مرضى (2.9%) من المستشفى على قيد الحياة [2]. وأظهر تحليل لاحق شمل 6,012 حالة توقف قلبي خارج المستشفى تابعة للهيئة تحقيق عودة الدورة الدموية التلقائية لدى 760 حالة (12.6%)، كما أظهر وجود ارتباط بعد ضبط العوامل الأخرى بين استخدام الإنعاش القلبي الرئوي الميكانيكي وعودة الدورة الدموية التلقائية (نسبة الأرجحية المعدلة 1.433؛ وفاصل الثقة 95%: 1.202–1.709). إلا أن هذه النتائج لم تثبت وجود فائدة سببية يمكن إرجاعها إلى إرسال وحدات دعم الحياة المتقدم بوصفها حزمة متكاملة من التدخلات [5]. وبوجه عام، حالت الاختلافات بين الدراسات الإحدى عشرة من حيث الفئات السكانية، وتعريفات التدخلات، ومؤشرات النتائج، دون التوصل إلى تقدير مجمع موثوق لأثر دعم الحياة المتقدم.

الخاتمة :تصف الأبحاث السعودية المنشورة ممارسات هيئة الهلال الأحمر السعودي في تقديم خدمات دعم الحياة المتقدم، وتكشف عن فجوات مهمة سريريًا في معدلات النجاة من التوقف القلبي، وآليات إرسال الوحدات، والنقل الإسعافي، وفرز حالات الإصابات. ومع ذلك، لا تثبت هذه الأبحاث أن دعم الحياة المتقدم، مقارنةً بتقديم دعم حياة أساسي عالي الجودة وفي توقيت مماثل، يؤدي بصورة مستقلة إلى تحسين فرص البقاء على قيد الحياة أو التعافي العصبي. وتتطلب المراجعة الحاسمة لفعالية خدمات دعم الحياة المتقدم التابعة للهيئة إجراء بحث منهجي قابل للتكرار، وتوفير سجلات فرز كاملة، وإجراء تقييمات لمخاطر التحيز، والاستناد إلى بيانات مقارنة معدّلة ومترابطة على مستوى المرضى.

الكلمات المفتاحية :دعم الحياة المتقدم؛ هيئة الهلال الأحمر السعودي؛ سيارات الإسعاف؛ دعم الحياة الأساسي؛ التوقف القلبي خارج المستشفى؛ الإنعاش؛ الإصابات؛ النتائج السريرية؛ توليف الأدلة.

1. Introduction

Emergency medical services provide early care for cardiac arrest, major trauma, respiratory failure, and other time-critical conditions. ALS extends the platform of BLS—recognition, CPR, ventilation, and defibrillation—with additional procedures such as supraglottic or endotracheal airway placement, intravenous or intraosseous access, medication administration and advanced rhythm assessment. The ability to deliver a procedure and evidence that the procedure improves long-term outcomes are distinct questions [12, 13].

In the Saudi setting, SRCA serves a geographically diverse population in which variations in time to dispatch, scene access, severity, bystander actions, and receiving-hospital capability can influence prognosis. A key methodological challenge is confounding by indication: sicker patients may be more likely to receive ALS resources. A second challenge is exposure misclassification: ALS-capable ambulance attendance is not identical to documented receipt of an advanced intervention.

The 2021 national SRCA OHCA analysis and the Saudi OHCA registry provide foundational descriptions of resuscitation activity and outcomes [1, 2]. Subsequent Riyadh OHCA, dispatcher and multiregional analyses extend information about bystander CPR, response intervals and selected interventions [3–5]. Trauma and airway studies provide important implementation context but should not be treated as direct ALS-versus-BLS effectiveness tests [6–11].

1.1. Review objective

This review evaluates what can—and cannot—be concluded about ALS effectiveness in SRCA ambulance services from 11 verifiable original studies, distinguishing patient outcomes from process indicators and direct SRCA clinical cohorts from indirect national or hospital-based contextual findings.

2. Methods

2.1. Review design and methodological integrity

The source document described a PRISMA 2020 systematic review with 348 records and 11 included studies but contained only two identifiable study rows and no auditable de-duplication or exclusion log. Its original flow diagram collapsed distinct screening stages into a single subtraction. The current revision therefore does not repeat the unverified 348→337→11 counts, construct a spurious PRISMA diagram, or assert that a new complete database-by-database search was executed. Instead, a structured, source-verified evidence review was undertaken. The original claim

of a completed PRISMA review must be reinstated only after the search files and full-text decisions are documented [14].

2.2. Information sources and date boundaries

Primary-study details, sample sizes, outcomes and bibliographic identifiers were checked against publicly accessible PubMed abstracts, full-text PubMed Central records, and original publisher pages on 22 October 2026. The original draft specified studies published from January 2020 through March 2025. To preserve that historical boundary, studies first published afterward are identified as later contextual updates (Alshahrani et al., June 2025; Khan et al., July 2025), not retrospectively counted as records obtained in the original search [5, 10]. The present verification is targeted and should not be represented as an exhaustive search across MEDLINE, Scopus, Embase, Web of Science, CINAHL and CENTRAL.

2.3. Evidence classification

Reports were grouped as: (A) direct SRCA OHCA/clinical-outcome data, (B) SRCA-linked systems, dispatch or trauma evidence, and (C) Saudi contextual studies without a separable SRCA ALS effect. Source study designs and outcome denominators were extracted verbatim where clear. A study was considered direct evidence for causal ALS effectiveness only if it measured an adequately specified ALS intervention or ALS-capable response against a suitable comparator and linked it to clinical outcomes with confounding adequately addressed. None of the identified reports met all these conditions.

2.4. Data extraction and evidence appraisal

The extracted fields were author, publication year, setting, study design, analytic denominator, main interventions, patient- or process-level outcomes, and limitations for causal interpretation. The study-by-study appraisal below describes observable design limitations. It is not a completed formal JBI, ROBINS-I, RoB 2, or GRADE assessment; those methods require documented, independent domain ratings by designated assessors. No reviewer count is asserted because the review team and its completed screening or duplicate extraction sheets could not be verified.

2.5. Synthesis

Findings were synthesized narratively by (1) OHCA and patient-centered outcomes, (2) advanced procedures and associated resuscitation practices, and (3) operational modifiers such as dispatch, trauma triage and advanced airway competence. Effect estimates were reported only for the outcomes and exposures originally modeled. Cross-study crude ROSC values were not pooled because cohort periods, case mix, definitions and potential overlaps differ.

3. Results

3.1. Verified evidence base

Eleven distinct empirical publications were verified for this structured evidence map: five relating to SRCA OHCA or dispatch, four describing SRCA traffic-injury, response, trauma-triage or trauma-practice questions, and two describing broader Saudi hospital-based airway or mixed-transport trauma outcomes. Two of these 11 were published after the original March 2025 cut-off; inclusion in this evidence map does not imply eligibility for the historical systematic-review flow. Table 1 details all 11 entries, replacing the nine placeholders in the source document.

Table 1. Eleven verified original studies relevant to SRCA ALS effectiveness and its clinical context

Study	Design, setting and population	Verified findings	Interpretive role
1. Alsofayan et al. (2021) [1]	National SRCA OHCA; retrospective cross-sectional; n=1,307; Apr–Jun 2021	ALS-unit 329 (25.2%); BLS-unit 978 (74.8%); ROSC 102 (7.8%); median response 13 min.	Direct SRCA clinical; no adjusted ALS/BLS outcome contrast.
2. Alabdali et al. (2024) [2]	National SOHAR prospective registry, 2019–2022; n=3,671	ROSC 275 (reported 7.4%); survival to discharge 107 (2.9%); favorable neurological status very uncommon.	SRCA-linked OHCA benchmark; ALS exposure not separately estimated.
3. Almiro et al. (2023) [3]	Riyadh SRCA OHCA; cross-sectional; n=1,023; Jun 2020–May 2021	Bystander CPR 130 (12.7%); shockable rhythm 131/742 (17.7%); response time mean 15.9 min.	SRCA case-mix/process; no ALS effect estimate.
4. Binhotan et al. (2023) [4]	Riyadh SRCA OHCA emergency calls; retrospective; 308 reviewed, 100 eligible	OHCA recognized in 62% of calls; median 303 s to recognition and 367 s to CPR; ROSC 10%.	SRCA dispatch/early BLS; not an ALS intervention comparison.
5. Alshahrani et al. (2025) [5]	National SRCA OHCA; retrospective; n=6,012; Jan–Jun 2024	ROSC 760 (12.6%); mechanical CPR adjusted OR 1.433 (95% CI 1.202–1.709) for ROSC; ALS/BLS configurations recorded.	Direct SRCA clinical update; published Jun 2025, after original cut-off.
6. Alsofayan et al. (2022) [6]	National SRCA road-traffic injury reports; retrospective; n=142,763	Pandemic-period fatality proportion highest during restrictions; pedestrians had OR 2.7 for death versus other road users.	SRCA injury outcomes; no ALS treatment contrast.
7. Alslamah et al. (2023) [7]	National SRCA road-traffic response; retrospective; n=95,372	Examined response-time distribution and sociodemographic/incident determinants.	SRCA process evidence; response time not proof of ALS efficacy.
8. Alenazi et al. (2021) [8]	Hospital-based Saudi paramedics; retrospective airway cases n=24; survey n=63 responses	Initial tracheal intubation successful 11/16 (69%) within two attempts; first-attempt supraglottic placement reported 100%.	Non-SRCA technical context; SRCA patients explicitly excluded.
9. Alharbi et al. (2024) [9]	Riyadh major trauma-center pedestrian registry; n=1,062; 2017–2022	SRCA transported 50.19%; hospital mortality 4.89%; intubation/mechanical ventilation 19.68%.	Mixed transport and hospital outcome; no isolated SRCA ALS benefit.
10. Khan et al. (2025) [10]	Riyadh SRCA dispatch records; retrospective geospatial; n=102,895	Among high-acuity red cases, 21.1% experienced trauma-center delay and 28.7% were undertriaged.	SRCA system update; published Jul 2025, after original cut-off.
11. Almuwallad et al. (2024) [11]	SRCA paramedic interviews; qualitative; n=20	Participants identified coordination, staffing, handover, readiness and information-quality barriers.	Implementation-only context; no patient outcome measurement.

Abbreviations: ALS, advanced life support; BLS, basic life support; OHCA, out-of-hospital cardiac arrest; ROSC, return of spontaneous circulation; SRCA, Saudi Red Crescent Authority. Values are study-specific; observational cohorts may overlap and must not be summed.

3.2. Study-by-study critical synthesis

Study 1 — Alsofayan et al. (2021) [1]

This national SRCA retrospective analysis is closest to the review question because it explicitly describes ALS- and BLS-capable responses to OHCA, together with prehospital ROSC and procedures. Of 1,307 cases, 329 received an ALS-unit response and 978 a BLS-unit response, while 102 achieved ROSC. Although procedural detail strengthens its operational relevance, the report does not provide a risk-adjusted ALS-versus-BLS association with hospital discharge or neurological recovery. Differences in arrest severity, crew availability, geography and timing may explain the distributions. Its strongest contribution is to establish the scale of SRCA resuscitation activity and the feasibility of recording exposure at crew level; it does not quantify the causal survival benefit of ALS.

Study 2 — Alabdali et al. (2024) [2]

SOHAR represents a valuable national, prospectively recorded OHCA registry with an endpoint extending beyond field ROSC. Its 3,671 cases include 275 with prehospital ROSC and 107 with survival to discharge, highlighting the gap between initial physiological recovery and patient survival. The paper draws on SRCA-attended incidents but is not an ALS-versus-BLS comparison and does not identify a separable adjusted treatment effect attributable to SRCA advanced procedures. The broad registry case mix and reporting standards are advantageous for benchmarking, while aggregation limits mechanism-specific inference. It should be treated as national outcome context, not proof of ALS effectiveness.

Study 3 — Almiro et al. (2023) [3]

The Riyadh SRCA analysis of 1,023 OHCA cases describes bystander activity, arrest setting, recorded rhythm and ambulance response intervals. Only 130 patients (12.7%) received bystander CPR; the mean EMS response was 15.9 minutes, and 131 of the 742 patients with available rhythm information had a shockable initial rhythm. The authors estimated predictors of receiving bystander CPR rather than outcomes caused by an ALS team. Its population overlaps in calendar time with some other Saudi OHCA reports, so independent denominators should not be assumed. The major contribution is exposure to important prognostic and service factors that must be adjusted for in future ALS studies.

Study 4 — Binhotan et al. (2023) [4]

This focused SRCA dispatch analysis reviewed 308 cardiac-arrest calls to obtain a selected sample of 100 analyzable adult calls. Correct recognition was documented for 62%, with a median 303 seconds to recognition and 367 seconds to first chest compression. ROSC occurred in 10% of the selected cohort. The selected-call design, historical recordings and exclusion restrictions limit generalizability, and the findings cannot determine whether ALS procedures provided after dispatch improve hospital survival. Nevertheless, the study identifies actionable process delays occurring before an ALS team can deliver its skills and supports the clinical logic of treating response quality as part of the treatment pathway.

Study 5 — Alshahrani et al. (2025) [5]

The most recent verified SRCA cardiac-arrest cohort in this evidence map included 6,012 cases recorded during the first half of 2024. ROSC was observed in 760 (12.6%). In multivariable regression, witnessed arrests and mechanical CPR device use were associated with higher odds of ROSC, while longer response times were associated with lower odds. These estimates refer to their respective modeled predictors; they do not identify the isolated effect of ALS-team dispatch or prove mechanical devices caused better outcomes. The paper contains information on EMS configurations but cannot replace a propensity-adjusted, appropriately specified ALS-versus-BLS effectiveness contrast. It was published after the original search cut-off and should be included only in an explicitly updated review.

Study 6 — Alsofayan et al. (2022) [6]
The nationwide SRCA traffic-injury study assessed 142,763 records before, during and after pandemic-related restrictions. Its mortality analysis identified elevated risk in pedestrian injuries relative to other road users and changes in accident burden and outcomes over time. Because the study compares event circumstances rather than BLS and ALS treatment strategies, its contribution lies in severity, geography and access-related case-mix considerations. It supports the need for careful injury stratification but cannot justify a claim that ALS improves outcomes in Saudi trauma patients.

Study 7 — Alslamah et al. (2023) [7]
Using 95,372 SRCA road-traffic incidents, this national retrospective analysis examined determinants of the interval between emergency notification and arrival at the scene. The size of the dataset is useful for understanding service-level variation, and the result is pertinent to rapid deployment, triage and equitable regional coverage. However, the exposure is response time, not actual ALS procedures, and the analytic endpoint is operational. Causal inference about patient survival would require linkage of time intervals to risk-adjusted injury outcomes and explicit intervention exposure. It should not be included in an ALS-survival meta-analysis.

Study 8 — Alenazi et al. (2021) [8]
This study directly examines the technical performance of advanced airway management among Saudi hospital-based paramedics but explicitly excluded SRCA patients from the clinical airway sample. Of 24 airway cases, initial tracheal intubation was attempted in 16, with 11 successful in the first two attempts; alternative supraglottic devices were successful in the small reported series. Paramedic responses also indicated limited exposure to difficult airway procedures. The results provide useful training and scope-of-practice context, but the small, selected non-SRCA sample and absence of linked survival endpoints render it indirect evidence for the paper's primary question.

Study 9 — Alharbi et al. (2024) [9]
This hospital-based pedestrian-trauma registry followed 1,062 patients; approximately half arrived by SRCA ambulance, and 4.89% died during their hospital episode. The study relates prehospital and hospital characteristics to subsequent patient outcomes, a level of linkage absent in some arrest reports. However, its source population mixes transportation modalities, and in-hospital procedures such as intubation cannot be assumed to have been delivered by SRCA crews before admission. Without disaggregated ALS exposure and comparable prehospital treatment groups, the overall mortality cannot be attributed to ALS care. The paper is best used to illustrate potential for linked trauma outcome research.

Study 10 — Khan et al. (2025) [10]
This geospatial analysis of 102,895 SRCA incident records across Riyadh quantified transport delays and undertriage in high-acuity trauma. It found that 21.1% of red-criteria cases experienced delays and 28.7% were taken to nontrauma centers under the study definitions. These measures identify opportunities to improve access to definitive care, a competing explanation for outcome variation that is independent of many advanced ambulance procedures. The study was published in July 2025, outside the original publication window, and did not compare risk-adjusted mortality among ALS and BLS recipients. It is a later systems-quality update, not a direct clinical ALS effectiveness trial.

Study 11 — Almuwallad et al. (2024) [11]
Interviews with 20 SRCA paramedics identified recurring problems in trauma response coordination, handover quality, information accuracy and accessibility, confidence, staffing and preparedness. Such experiential findings can inform implementation strategies for complex prehospital interventions, particularly where crew competency and documentation may influence treatment fidelity. This qualitative design does not provide event-level patient counts, treatment effect estimates or survival outcomes. Accordingly, it belongs in the implementation context rather than the clinical comparative evidence set. Including its role explicitly avoids presenting professional opinion data as numerical evidence of improved survival.

3.3. Outcome comparability across evidence types

The assembled sources fall into four outcome families: physiological resuscitation (ROSC), downstream patient survival (discharge or hospital death), procedural performance (airway attempts and CPR recognition timing), and system-process outcomes (response time, destination appropriateness, interview themes). These families answer different clinical questions. ROSC may be associated with survival but is neither a substitute for long-term functional outcome nor a homogeneous denominator across reports. A single quantitative ALS effect cannot be constructed by pooling values from different families.

Table 2. Outcome types, eligible interpretation and methodological cautions

Evidence / studies	Measured endpoint	What the endpoint supports	What it cannot establish
OHCA [1–5]	Prehospital ROSC; in [2], discharge survival	Setting-specific resuscitation and early outcome benchmarks	Comparative ALS survival advantage without adjusted exposed/comparator data.
Airway [1, 8]	Procedures performed; placement success	Operational practice and limited technical feasibility	Improved neurological recovery or mortality, particularly for SRCA from non-SRCA cases.
Trauma [6, 9]	Injury mortality, hospital outcome	Burden and clinical patterns in selected populations	Effect of ALS crew or on-scene intervention without exposure-specific analysis.
Operations [4, 7, 10]	CPR call timing, response intervals, trauma destination	Dispatch and transport quality targets	Patient survival effect merely from process metrics.
Workforce [11]	Interview themes	Implementation obstacles and training priorities	Any measured patient-level effect.

3.4. Methodological limitations by study type

For retrospective SRCA case-series reports, the principal risks are incomplete arrest characterization, differential exposure to ALS according to illness severity, missing intervention timestamps and unmeasured post-arrival treatment. Registry data can improve completeness and consistency but do not eliminate confounding and may omit outcomes after hospital transfer. Telephone-call analyses permit accurate reconstruction of dispatch processes but can be subject to selection and information bias when recordings are missing or caller criteria restrictive. Single-center or hospital-based airway and trauma cohorts raise additional concerns about selection and transferability to national SRCA operations. Qualitative interviews are informative for implementation yet lack comparative clinical endpoints. These are study design considerations rather than fabricated domain-level risk-of-bias ratings.

3.5. Resuscitation and survival

Alsofayan et al. documented CPR attendance predominantly by BLS units, a minority of ALS attendance, and a 7.8% prehospital ROSC proportion among 1,307 OHCA cases [1]. These descriptive statistics do not compare adjusted ROSC or discharge survival between ALS and BLS groups. The SOHAR analysis reported 7.4% prehospital ROSC and 2.9% survival to hospital

discharge in a separate cohort of 3,671 patients [2]. The difference in study period, inclusion criteria, and ascertainment precludes interpreting these percentages as either a direct comparison of team models or a time trend.

The Riyadh cohort of 1,023 SRCA patients found 12.7% receipt of bystander CPR and a mean response interval of 15.9 minutes, providing relevant prehospital context without isolating the effectiveness of ALS [3]. A retrospective SRCA call-recording study identified OHCA in 62% of analyzed calls, and the median interval from call receipt to first compression was 367 seconds [4]. Both studies concern important earlier parts of the survival chain, not incremental ALS procedures.

A later national analysis comprising 6,012 cases found ROSC in 12.6%. Witnessed arrest (adjusted OR 2.145, 95% CI 1.816–2.534), shorter response time (adjusted OR per minute 0.981, 95% CI 0.970–0.991), and mechanical CPR use (adjusted OR 1.433, 95% CI 1.202–1.709) were associated with ROSC [5]. These are observational associations for specific predictors, not randomized or otherwise demonstrably causal ALS-versus-BLS effects. This study postdates the draft's March 2025 publication cut-off.

3.6. Advanced airway and other ALS procedures

The SRCA OHCA report recorded airway support, vascular access, and epinephrine use, but did not supply patient-level adjusted contrasts linking procedure timing to discharge survival or neurological recovery [1]. A hospital-based Saudi paramedic series provides a separate example of procedural success: 24 airway cases yielded 11 successful initial intubations among 16 attempts within two attempts; supraglottic airway success was reported among the smaller alternative-device group [8]. This study explicitly excluded SRCA transport patients, so these rates cannot be generalized to SRCA crews or interpreted as comparative survival benefit.

ALS must also be separated from high-quality CPR and defibrillation, which are essential components of BLS and resuscitation systems. International comparisons in trauma have not demonstrated a uniformly superior ALS effect, and specialist physician-staffed critical care beyond standard ALS represents a different exposure [12, 13].

3.7. Trauma, access and service delivery

In 142,763 SRCA traffic-injury records, Alsofayan et al. documented differences in mortality patterns across pandemic-related restrictions and a higher death risk among pedestrians than other road-user categories [6]. The national 95,372-case response-time analysis described variation in EMS access related to sociodemographic and event features [7]. Neither report establishes intervention-specific ALS benefit.

The mixed-transport Riyadh trauma registry of 1,062 pedestrian injuries reported that approximately half arrived via SRCA ambulance, while total in-hospital mortality was 4.89% [9]. Because transport mode and patient severity were not compared as an ALS exposure, no SRCA treatment effect can be inferred. A later SRCA trauma-dispatch analysis reported delays and undertriage among high-acuity incidents, signaling system-improvement opportunities but not ALS mortality effects [10]. SRCA paramedic interviews added implementation considerations involving handovers, information access, staffing and preparedness [11].

3.8. Critical appraisal and certainty boundaries

The key cross-cutting limitations are (i) nonrandom ALS selection, (ii) absence of consistently measured advanced procedures and their timing, (iii) endpoint heterogeneity (ROSC, hospital discharge, intervention success, response time, interview themes), (iv) potential cohort overlap, and (v) limited adjusted, linked hospital outcomes. The analytical confidence supported by these reports is greatest for descriptive frequencies within their reported settings; certainty about a causal survival advantage of ALS over BLS remains very low or unassessable. This wording represents a narrative judgment rather than a formal GRADE rating.

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4. Discussion

4.1. Interpretation of the evidence

The central finding is not that advanced interventions lack clinical value. Instead, the available Saudi studies do not adequately isolate their incremental contribution beyond timely BLS and appropriate hospital transfer. ROSC is a meaningful intermediate event, but it is not equivalent to survival to discharge with favorable neurological status. ALS units are often deployed to patients at higher baseline risk; even comparisons with seemingly similar unadjusted outcomes may therefore be misleading.

In addition to within-study confounding, some reports may draw on overlapping SRCA databases or shared time periods [1–3, 5]. Summing denominators or calculating a naive mean ROSC rate would double count unknown cases and disregard between-study differences. The later 2025 findings may inform contemporary interpretation, but cannot be inserted retroactively into a search said to have ended in March 2025.

4.2. Implications for SRCA clinical practice

Preserving short times to recognition, effective CPR, defibrillation when indicated, accurate triage and timely destination decisions should remain core quality-improvement objectives [1–7, 10]. Advanced airway and drug protocols warrant monitoring by indication, number of attempts, administration timing, adverse events and outcomes rather than procedure frequency alone. Training should explicitly address competency retention, team coordination and effective handovers [8, 11].

4.3. Implications for research

A more definitive study should link SRCA electronic patient care reports to hospital survival and neurological outcomes, prespecify ALS exposure as both crew capability and actual procedures, and adjust for arrest witnessing, initial rhythm, etiology, bystander CPR, response and transport intervals, comorbidity and regional access. Target-trial emulation or carefully designed prospective cohort analysis could reduce, though not eliminate, nonrandom-treatment bias. Where interventions differ across conditions, condition-specific contrasts should be preferred to an undifferentiated ALS bundle.

4.4. Review limitations

This is a verified, purposively constructed 11-study evidence map and critical narrative synthesis. It is not claimed to be a complete systematic review because the original database strategies, per-database last-search dates, de-duplication records, screening decisions, detailed extraction sheets and formal independent risk-of-bias assessments were unavailable. The distinction between direct clinical, operational and contextual evidence is explicit to prevent overinterpretation. Subsequent literature outside the original cut-off is labeled rather than concealed.

5. Conclusion

Current SRCA-associated research confirms that ALS capability is deployed in Saudi ambulance resuscitation and documents important barriers across cardiac arrest, emergency dispatch and trauma pathways. However, the eleven studies in this structured evidence map do not establish an independent improvement in discharge survival or favorable neurological outcomes attributable to ALS compared with BLS. Clinical and policy decisions should emphasize high-quality basic resuscitation, appropriate advanced intervention, standardized documentation and linked outcome evaluation. A claim of a PRISMA-compliant systematic review with 11 formally eligible studies should not be made until the missing screening and appraisal materials are supplied.

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