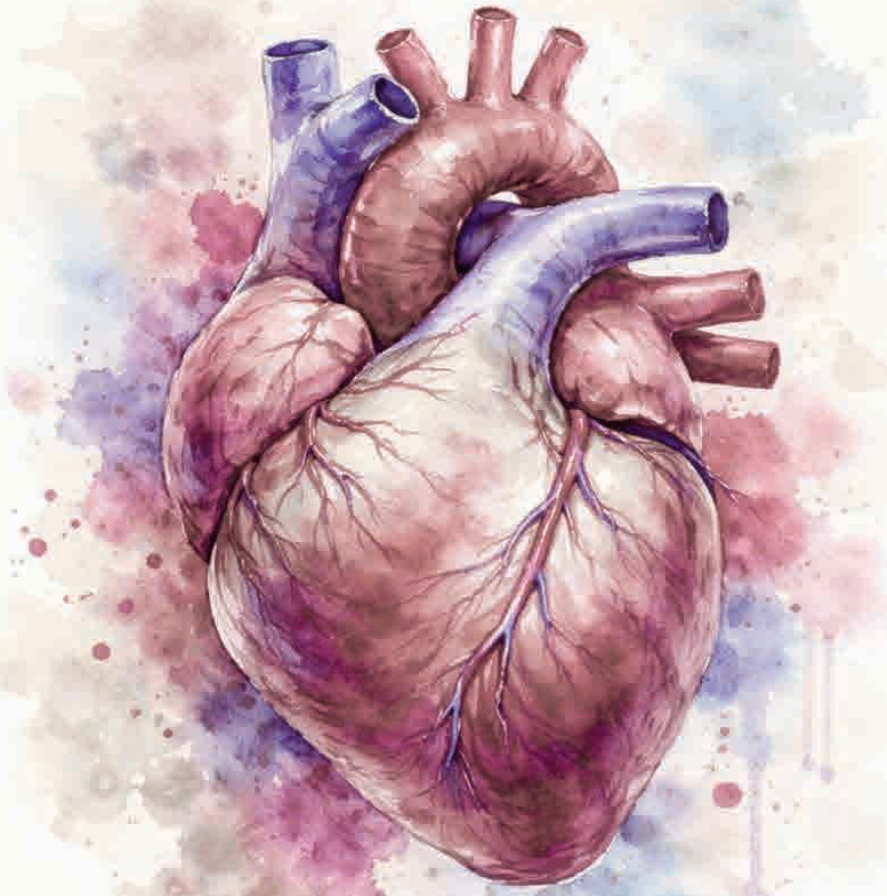
SCENARIO®

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WEBMASTER

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SEGRETERIA DI REDAZIONE

Aniarti - scenario@aniarti.it
Tel. 340.4045367
E-mail: aniarti@aniarti.it
Aut. Tribunale di Arezzo 4/84 R.S.

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Francesca Angelelli - scenario@aniarti.it

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Comitato Direttivo - Triennio 2026/2028

SCELSI SILVIA
Presidente
presidenza@aniarti.it
Istituto IRCCS "G. Gaslini" di Genova
Direttore D.I.P.S., Genova
scelsi@aniarti.it

ROMIGI GAETANO
Vice-Presidente
vicepresidenza@aniarti.it
ASL ROMA 2 Polo formativo "Ospedale S. Eugenio" - Formazione Universitaria e Master – Università degli studi di Roma Tor Vergata, Roma
garomigi@aniarti.it

ZANARDO DAVIDE
Tesoriere
tesoreria@aniarti.it
DAME, CdS infermieristica Università degli Studi di Udine
d.zanardo@aniarti.it

SADDI SIMONA
Segretario
segretario@aniarti.it
AOU Città della Salute e della Scienza di Torino – Coordinatore infermieristico P.O. "Molinette" Anestesia, rianimazione e neurorianimazione, Torino
s.saddi@aniarti.it

FRANCESCA ANGELELLI
Direttore della Rivista
scenario@aniarti.it
Fondazione Policlinico Universitario "Agostino Gemelli" IRCCS Università Cattolica del Sacro Cuore di Roma - Rianimazione Roma
scenario@aniarti.it

CONSIGLIERI

LIMONTI FRANCESCO
Rappresentante Macro Area Sud e Isole
A.O. Cosenza – Anestesia e rianimazione, Cosenza, Italia
sud-isole@aniarti.it

FAVERO VALTER
Azienda Ospedaliera di Padova
T.I.P.O. Cardiochirurgia, Padova, Italia
valter.favero@aniarti.it

IMBRIACO GUGLIELMO
Centrale Operativa 118 Area Omogenea Emilia Est, Ospedale Maggiore, AUSL di Bologna, Italia
g.imbriaco@aniarti.it

MADEO MARIO
Fondazione IRCCS "Ca' Granda" Ospedale Maggiore Policlinico di Milano - Terapia Intensiva pediatrica, Milano, Italia
m.madeo@aniarti.it

SERVELI SIMONA
IRCCS "G. Gaslini" di Genova – Responsabile infermieristica piattaforma Area Critica D.I.P.S. Genova, Italia
s.serveli@aniarti.it

CINI SILVIA
Dipartimento emergenza urgenza,
Centrale operativa emergenza Sanitaria
Azienda USL Toscana sud est, Arezzo, Italia
silviacini2014@gmail.coml

PINTO FLORIANA
Incarico di funzione organizzativa di coordinamento - Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Italia
Floriana.pinto89@gmail.com

DECARO ROBERTA
Unità di Anestesia e Terapia Intensiva Generale, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Bologna, Italia
r.decaro2@gmail.com

BUCCIONI EMANUELE
Dipartimento Urgenza Emergenza - U.O.C. Terapia Intensiva e Anestesiologia. ASL Pescara, Pescara, Italia
emanuele.buccione@asl.pe.it

GARAVANTE FRANCESCO
Dipartimento di Area Critica, U.O.C Anestesia e Rianimazione - Terapia Intensiva, Presidio Ospedaliero "San Giuseppe Moscati" di Aversa (CE), Azienda Sanitaria Locale di Caserta, Italia
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Dalla competenza dichiarata alla competenza riconosciuta: le lauree magistrali specialistiche e la sfida di sistema per l'infermieristica di area critica

From declared competence to recognized competence: specialized master's degrees and the systemic challenge for critical care nursing

Silvia Scelsi, Francesco Limonti, Francesca Angelelli

ANIARTI, Associazione Nazionale Infermieri di Area Critica

Con il decreto ministeriale n. 159 del 6 febbraio 2026 la classe di laurea magistrale LM/SNT1 è stata articolata in due sezioni: Scienze infermieristiche e ostetriche, e Scienze infermieristiche specialistiche. La seconda è divisa a sua volta in tre percorsi: Cure primarie e infermieristica di famiglia e comunità, Cure neonatali e pediatriche, e Cure intensive ed emergenza.[1] Il decreto n. 177 del 25 febbraio 2026, adottato di concerto con il Ministero della Salute, ha contestualmente rivisto la classe triennale L/SNT1.[2] A più di trent'anni dall'ingresso della formazione infermieristica nell'università, avviato con il decreto legislativo 502/1992,[3] la specializzazione clinica entra così per la prima volta nel secondo ciclo dell'ordinamento universitario, anziché restare affidata ai master di primo livello, ai quali la legge 43/2006 collega oggi l'esercizio della funzione specialistica.[4]

Questo editoriale vuole riflettere sul fatto che il successo della riforma non dipenderà soltanto dalla qualità dei nuovi curricula, ma dalla capacità del sistema di riconoscere ciò che essi produrranno. Senza un allineamento tra titolo accademico, regolazione dell'esercizio professionale e organizzazione del lavoro, il rischio concreto è quello di un titolo senza ruolo: una competenza dichiarata dall'ordinamento e certificata dall'università, ma non riconosciuta nei contesti di cura. Per le persone assistite la posta in gioco è tangibile: poter contare, nei momenti di maggiore vulnerabilità, su professionisti in grado di riconoscere precocemente l'instabilità clinica e di governare processi assistenziali complessi. L'argomentazione è sviluppata dal punto di osservazione dell'area critica, il percorso che ha raccolto la quota più ampia di candidature nella prima selezione nazionale.

Una riforma di sistema

La riforma è l'esito di un iter pluriennale, dalla proposta del Consiglio Universitario Nazionale del dicembre 2024 al parere favorevole del Consiglio Superiore di Sanità del luglio 2025, fino ai pareri della Conferenza dei Rettori e delle commissioni parlamentari, che ne rafforza la legittimazione tecnica.[1] Due elementi ne qualificano la natura di intervento di sistema. Il primo è il concerto con il Ministero della Salute nella revisione della classe triennale, che sopprime il riferimento all'infermiere pediatrico e garantisce il completamento dei percorsi agli studenti iscritti fino all'anno accademico 2027/2028:[2] la competenza pediatrica avanzata viene così ricondotta al secondo ciclo. Il secondo è l'architettura curriculare. I due anni magistrali, con un tirocinio non inferiore a 30 crediti formativi,[1] non sono una sommatoria di insegnamenti, ma la prosecuzione, in un'ottica quinquennale, del percorso triennale: costruiscono progressivamente il profilo dello specialista attraverso un'esperienza clinica sempre più intensa, laboratori e simulazione avanzata; ambito, quest'ultimo, in cui l'area critica vanta una consolidata tradizione metodologica.

L'area critica come condizione

Il profilo dello specialista recepisce una concezione di area critica che l'infermieristica italiana, e ANIARTI in particolare, ha elaborato sin dagli anni Ottanta: non un perimetro fisico – la terapia intensiva, il pronto soccorso – ma una condizione assistenziale. Il decreto definisce infatti l'infermiere specialista in cure intensive e dell'emergenza come "il professionista responsabile dei processi infermieristici per la presa in carico delle persone di ogni fascia d'età in condizioni di instabilità o potenziale instabilità clinica."[1] Le competenze attese sono enunciate in termini operativi: effettuare e interpretare il monitoraggio clinico e strumentale, invasivo e non invasivo, delle funzioni vitali; gestire le situazioni di emergenza-urgenza mediante manovre rianimatorie avanzate, in conformità con algoritmi, protocolli e linee guida; "prescrivere trattamenti assistenziali quali presidi sanitari, ausili, tecnologie specifiche."[1]

È quest'ultima formulazione ad aver alimentato il dibattito interprofessionale sul confine tra "prescrivere" e "richiedere". Il testo, tuttavia, circoscrive la prescrizione a trattamenti assistenziali, presidi e tecnologie: non configura un potere generale di prescrizione farmacologica, né istituisce una nuova professione. Il confronto europeo aiuta a collocare la questione. Nei Paesi europei in cui esistono ruoli di pratica avanzata in area critica, la preparazione di livello magistrale è raccomandata nella maggior parte dei casi, ma solo sei riconoscono un'autorità prescrittiva e appena quattro una piena autonomia professionale.[5] L'Italia si colloca dunque in una posizione intermedia, coerente con uno svilup-

Corrispondente: Silvia Scelsi, Presidente ANIARTI, via Francesco Nullo 6°, 16147, Genova Italia.
E-mail: presidenza@ANIARTI.it

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po incrementale del ruolo. La questione rilevante non è se lo specialista "prescriva", ma se il suo ambito di esercizio sia definito con chiarezza sufficiente a garantire la sicurezza delle persone assistite e a rendere esigibile la responsabilità professionale.

Certificare le competenze

Sul piano disciplinare, ANIARTI ha proposto una matrice che traduce gli obiettivi formativi del decreto in uno strumento per la progettazione dei curricula, richiamando il Synergy Model dell'American Association of Critical-Care Nurses secondo cui sono le caratteristiche della persona assistita e della sua famiglia a orientare le competenze infermieristiche, con esiti ottimali quando le due dimensioni si allineano,[7] con la tassonomia del progetto Tuning, che descrive 47 competenze specifiche dell'infermieristica organizzate in cinque domini.[8,9] Diciotto di queste, ritenute le più pertinenti all'area critica, sono declinate sui tre livelli di esito del modello Synergy – persona assistita, professionista, sistema – e sui quattro pilastri della pratica avanzata propri dei framework internazionali: pratica clinica, leadership, formazione e ricerca,[10,11] fermo restando il primato della componente clinica.

Perché la matrice diventi uno standard condiviso sono necessari tre passaggi. Il primo è la trasparenza del metodo con cui le competenze sono state selezionate, da documentare mediante tecniche di consenso formalizzate e da sottoporre a validazione di contenuto. Il secondo è la calibrazione di livello: le competenze Tuning descrivono in larga misura il profilo dell'infermiere generalista e vanno ricondotte ai descrittori del secondo ciclo, corrispondenti al livello 7 del Quadro europeo delle qualifiche; allo stesso modo, va esplicitata la trasferibilità al contesto italiano del Synergy Model, sviluppato nel sistema statunitense di certificazione. Il terzo passaggio, decisivo, è la traduzione delle competenze in attività osservabili e valutabili nella pratica. Le *entrustable professional activities*, unità di pratica professionale che possono essere affidate al discente quando ne abbia dimostrato la padronanza,[12] offrono un ponte operativo tra competenza dichiarata e competenza agita, perché collocano la certificazione al livello del "fare" e non soltanto del "sapere come fare."[13] È su questo terreno, un set nazionale di competenze minime, certificate dall'università e verificabili nei contesti di lavoro, che la comunità scientifica è chiamata a un contributo dirimente, anche per evitare che nove sedi producano nove profili diversi.

Regolare e contrattualizzare il ruolo

Il nodo più rilevante riguarda il rapporto tra il nuovo titolo e gli strumenti che, nel sistema italiano, traducono la formazione in funzioni. La legge 43/2006 attribuisce la funzione specialistica a chi è in possesso del master di primo livello,[4] e la contrattazione collettiva continua ad ancorare ai titoli previsti da quella legge l'incarico di "professionista specialista."[14] Allo stato, il laureato magistrale specialista non dispone di un riconoscimento contrattuale proprio. Lo scenario più coerente vedrebbe il master universitario – titolo di almeno 60 crediti, da non confondere con il *Master's Degree* dei sistemi anglosassoni, che corrisponde alla nostra laurea magistrale – ricondotto a una funzione di perfezionamento, utile all'incarico di professionista esperto, riservando la funzione specialistica al laureato magistrale. Ciò richiede la revisione della legge 43/2006 e un intervento nella prossima tornata contrattuale; in loro assenza si replicherebbe l'esperienza della laurea magistrale a orientamento gestionale, il cui possesso non si è tradotto, di per sé, nell'accesso alle funzioni corrispondenti. La scelta di non rendere il titolo abilitante è comprensibile: una nuova abilitazione avrebbe richiesto l'istituzione di un nuovo profilo professionale, con il rischio di arrestare l'intera riforma. Secondo un'interpretazione diffusa, il campo proprio di attività resta definito, ai sensi della legge 42/1999, dal profilo professionale, dagli ordinamenti didattici e dal codice deontologico,[15] e il nuovo ordinamento ne estende il perimetro senza necessità di un'ulteriore abilitazione. È un'interpretazione ancora da consolidare: la norma richiama gli ordinamenti dei corsi di diploma universitario e di formazione post-base e, in assenza di un profilo distinto, le aziende sanitarie non dispongono di un riferimento univoco per attribuire funzioni specialistiche. Forme di riconoscimento pubblico del titolo, per esempio presso gli Ordini professionali, e indirizzi regionali sull'impiego degli specialisti nelle reti tempo-dipendenti potrebbero colmare questa zona grigia.

L'esperienza spagnola mostra il costo di un simile disallineamento. Il Real Decreto 450/2005 ha istituito sette specialità infermieristiche; quella in *cuidados médico-quirúrgicos*, che comprende l'ambito critico, risultava ancora priva di un programma formativo approvato e di posti di formazione quasi vent'anni dopo.[16,17] Il quadro europeo è coerente: in un'indagine su 24 Paesi la formazione post-base in area critica era presente in 17, ma la specialità era formalmente riconosciuta soltanto in 13, e la mancata protezione del titolo era indicata come barriera in quasi la metà dei Paesi rispondenti.[18] Una specialità dichiarata ma non riconosciuta resta, di fatto, una specialità che non esiste.

Capacità formativa ed equità territoriale

I dati della prima selezione smentiscono il timore di una scarsa attrattività. Per l'anno accademico 2026/2027 oltre 3.300 candidati hanno concorso per 759 posti; il percorso in cure intensive ed emergenza ha raccolto circa il 60% delle domande, con punte superiori a 20 candidati per posto.[19] Il contrasto con il primo ciclo è netto: il rapporto tra domande e posti nei corsi di laurea in infermieristica è sceso da 1,6 nel 2019 a 1,04 nel 2024, in un Paese in cui la densità di infermieri 6,9 per 1.000 abitanti nel 2023, è inferiore di oltre il 20% alla media dell'Unione europea.[20] Un percorso di carriera clinica credibile può dunque diventare una leva di attrattività e di permanenza nella professione. Proprio la carenza di personale, d'altra parte, impone che la specializzazione non sottragga competenze all'assistenza diretta, ma le concentri dove la complessità clinica è maggiore.

Il vincolo, quindi, non è la domanda ma la capacità formativa. Le nove sedi attivate per le cure intensive e l'emergenza, per complessivi 260 posti, si concentrano nel Centro-Nord: l'unica sede del Mezzogiorno è L'Aquila, e nessuno dei tre percorsi è attivo in Molise, Campania, Puglia, Basilicata, Calabria, Sicilia e Sardegna.[21] La disponibilità di tutor clinici e di sedi di tirocinio realmente specialistiche, la barriera più citata allo sviluppo della formazione in area critica in Europa,[18] condizionerà l'espansione dei posti e l'omogeneità degli esiti formativi. In questa fase iniziale è ammissibile che parte del tutorato si avvalga di professionisti non infermieri per competenze tecniche di frontiera, purché il governo del processo assistenziale resti in capo agli infermieri. Resta aperta, infine, la questione della selezione: una prova nazionale a risposta multipla misura conoscenze, non necessariamente il potenziale per la pratica avanzata, e il peso da attribuire all'esperienza clinica pregressa merita una riflessione che non penalizzi i più giovani né svaluti l'esperienza maturata sul campo.

Cosa misurare

La riforma è anche un'occasione di ricerca che la comunità infermieristica non dovrebbe mancare. Le evidenze internazionali sul ruolo dell'infermiere di pratica avanzata nei contesti di emergenza e di area critica indicano esiti non inferiori, e talvolta migliori, in termini di qualità dell'assistenza, esiti clinici, soddisfazione e costi;[22] derivano tuttavia in prevalenza da studi osservazionali condotti in sistemi con assetti regolatori, inclusa l'autorità prescrittiva, diversi dal nostro, e la loro trasferibilità va considerata con cautela. Analogamente, l'associazione tra livello di istruzione degli infermieri e mortalità ospedaliera osservata in nove Paesi europei[23] sostiene la plausibilità del legame tra formazione ed esiti, ma riguarda la formazione di base e non la specializzazione.

Servono almeno tre linee di lavoro. La prima è la valutazione dell'introduzione dei nuovi ruoli secondo framework consolidati come PEPPA, che accompagnano il processo dalla definizione del bisogno assistenziale alla valutazione degli esiti.[24] La seconda è uno studio di coorte nazionale dei laureati, che documenti collocazione, traiettorie di carriera e utilizzo effettivo delle competenze. La terza è la misurazione di esiti sensibili all'assistenza infermieristica nei contesti in cui operano gli specialisti, insieme alla validazione formale della matrice di competenze. Anche l'impatto delle tecnologie di monitoraggio avanzato e dell'intelligenza artificiale sul contenuto del ruolo andrà studiato, anziché presupposto.

Conclusioni

In un sistema in cui la qualità dei corsi è garantita dall'accreditamento istituzionale delle università[25] e non da un accreditamento professionale dei programmi, come avviene in altri Paesi, le società scientifiche hanno la responsabilità di presidiare gli standard di competenza attesi, entrando nel merito dei piani di studio e degli insegnamenti. La sfida, in definitiva, è culturale prima ancora che ordinamentale: passare dalla competenza dichiarata – enunciata dal decreto e mappata dalla matrice – alla competenza riconosciuta, certificata dal percorso accademico, verificabile nella pratica, valorizzata dal contratto e misurata nei suoi esiti per le persone assistite. Solo a queste condizioni la laurea magistrale specialistica sarà, per l'infermieristica italiana, il giro di boa che il suo ingresso nell'università ha rappresentato una generazione fa.

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Perceptions and use of the vacuum mattress in prehospital trauma care: a cross-sectional survey

Percezioni e utilizzo del materasso a depressione nell'assistenza traumatologica preospedaliera: un'indagine trasversale

Lorenzo Galli,[1] Leonardo Ceccanti,[2] Ilario Bocchi,[3] Flavio Gheri[4,5]

[1]Registered Nurse, Cardiac Rehabilitation Unit, Auxilium Vitae Volterra S.p.A., Volterra; [2]Clinical Tutor, Bachelor's Degree Program in Nursing, University of Florence, Empoli Campus; [3]Prehospital Emergency Medical Service (EMS 118), Empoli, USAR Team, Tuscany Region; [4]Prehospital Emergency Medical Service (EMS 118), Empoli; [5]PhD Candidate in Nursing and Public Health Sciences, University of Rome Tor Vergata, Rome, Italy

ABSTRACT

Introduction: spinal immobilization has traditionally been considered a key component of prehospital trauma care to prevent secondary spinal cord injury. However, growing evidence has questioned the routine use of rigid immobilization such as spine board, highlighting potential complications and limited clinical benefit. In response, the concept of spinal motion restriction has been introduced, promoting more selective approaches to spinal stabilization. Despite evolving recommendations, variability in clinical practice persists, and the perceptions and decision-making processes of prehospital providers regarding immobilization devices remain poorly explored.

Materials and Methods: a cross-sectional observational survey was conducted among prehospital healthcare professionals operating within the emergency medical services system of Azienda USL Toscana Centro, Italy. A structured questionnaire consisting of 15 multiple-choice items was developed to assess knowledge, perceptions, and reported practices regarding the use of spinal immobilization devices, with particular focus on the vacuum mattress. Responses were collected anonymously through an online survey platform and analyzed using descriptive statistics.

Results: a total of 86 prehospital professionals participated in the survey, including nurses (22.1%) and advanced rescuers (77.9%). While the vacuum mattress was perceived by 74.4% of respondents as the most effective immobilization device, the spine board was considered the fastest device by 82.6%. Despite this perceived effectiveness, the vacuum mattress appeared to be rarely used in clinical practice, with 94.2% of participants reporting fewer than five uses per year.

Conclusions: a discrepancy exists between participants' perceived effectiveness and the actual use of spinal immobilization devices in prehospital trauma care. Operational factors such as application speed, provider familiarity, and logistical considerations may influence device selection. Improving training and aligning clinical practice with evolving SMR recommendations may support more consistent and evidence-informed trauma care.

Key words: emergency medical services; wounds and injuries; spinal injuries; immobilization; vacuum mattress.

RIASSUNTO

Introduzione: l'immobilizzazione spinale è stata tradizionalmente considerata una componente fondamentale dell'assistenza traumatologica preospedaliera per prevenire lesioni secondarie al midollo spinale. Tuttavia, prove sempre più numerose hanno messo in discussione l'uso di routine di metodi di immobilizzazione rigidi, come la tavola spinale, evidenziandone le potenziali complicanze e i benefici clinici limitati. In risposta a ciò, è stato introdotto il concetto di limitazione del movimento spinale, che promuove approcci più selettivi alla stabilizzazione della colonna vertebrale. Nonostante l'evoluzione delle raccomandazioni, persiste una variabilità nella pratica clinica e le percezioni e i processi decisionali degli operatori preospedalieri riguardo ai dispositivi di immobilizzazione rimangono poco studiati.

Materiali e Metodi: è stata condotta un'indagine osservazionale trasversale tra gli operatori sanitari preospedalieri che operano nell'ambito del sistema dei servizi medici di emergenza dell'Azienda USL Toscana Centro, in Italia. È stato sviluppato un questionario strutturato composto da 15 domande a scelta multipla per valutare le conoscenze, le percezioni e le pratiche riportate relative all'uso dei dispositivi di immobilizzazione spinale, con particolare attenzione al materasso a depressione. Le risposte sono state raccolte in forma anonima tramite una piattaforma di sondaggi online e analizzate utilizzando statistiche descrittive.

Risultati: hanno partecipato al sondaggio un totale di 86 professionisti del settore preospedaliero, tra cui infermieri (22,1%) e soccorritori avanzati (77,9%). Mentre il materasso a depressione è stato percepito dal 74,4% degli intervistati come il dispositivo di immobilizzazione più efficace, la tavola spinale è stata considerata il dispositivo più veloce dall'82,6%. Nonostante questa percezione di efficacia, il materasso a depressione sembrava essere utilizzato raramente nella pratica clinica, con il 94,2% dei partecipanti che riferiva meno di cinque utilizzi all'anno.

Conclusioni: esiste una discrepanza tra l'efficacia percepita dai partecipanti e l'uso effettivo dei dispositivi di immobilizzazione spinale nell'assistenza traumatologica preospedaliera. Fattori operativi quali la rapidità di applicazione, la familiarità degli operatori e considerazioni logistiche possono influenzare la scelta del dispositivo. Migliorare la formazione e allineare la pratica clinica alle raccomandazioni in continua evoluzione della SMR potrebbe favorire un'assistenza traumatologica più coerente e basata sull'evidenza.

Parole chiave: emergenza sanitaria territoriale; trauma; lesioni spinali; immobilizzazione spinale; materasso a depressione.

Correspondence: Flavio Gheri, University of Rome Tor Vergata, Via Cracovia 50, 00133 Rome, Italy.
E-mail: flavio.gheri@unifi.it

Introduction

Traumatic injuries represent a major global health challenge and remain a leading cause of death and disability worldwide, particularly among young adults. Early prehospital management plays a critical role in reducing mortality and preventing secondary complications. Emergency Medical Services (EMS) providers are therefore required to rapidly assess trauma patients and implement appropriate stabilization strategies before hospital arrival.[1] Spinal protection has traditionally been regarded as a cornerstone of prehospital trauma care. Since the 1960s, suspected spinal injuries have commonly been managed through the routine application of rigid cervical collars and spine boards to minimize spinal movement and prevent secondary neurological injury.[2] However, the evidence supporting routine spinal immobilization has increasingly been questioned. Several studies have reported uncertain clinical benefits while highlighting potential complications associated with rigid immobilization, including pain, pressure injuries, respiratory impairment, delayed airway management, and increased intracranial pressure.[2,3] These concerns have contributed to a gradual shift from routine spinal immobilization toward the concept of Spinal Motion Restriction (SMR), which aims to minimize unnecessary spinal movement while avoiding potentially harmful interventions. Accordingly, a joint position statement from major trauma and emergency medicine organizations emphasized that true immobilization cannot be achieved in the prehospital setting and that management should instead focus on limiting spinal motion while prioritizing overall patient care.[4] In parallel with this conceptual evolution, increasing attention has been directed toward the performance of different stabilization devices used in prehospital trauma care. Various devices, including spine boards, vacuum mattresses, and scoop stretchers, are commonly employed depending on local protocols and operational contexts. Biomechanical and simulation studies have produced heterogeneous findings regarding their performance. For example, experimental analyses of cervical spine motion during ambulance transport have suggested that different immobilization techniques may provide variable levels of motion restriction depending on device configuration and clinical circumstances.5 Operational factors also influence device selection in the prehospital environment. Time-critical scenarios may favor devices that allow faster stabilization and rapid patient transport, whereas others may provide greater comfort or stabilization at the expense of longer application times.[6,7] Consequently, despite the growing body of literature on spinal stabilization techniques, considerable variability persists in clinical practice, with immobilization strategies often influenced by local protocols, provider experience, and operational constraints rather than standardized evidence-based approaches.[3] Although many studies have evaluated the biomechanical performance or clinical outcomes of different stabilization devices, relatively little attention has been paid to prehospital providers' knowledge, perceptions, and decision-making processes. Understanding these factors may help identify barriers to the implementation of evidence-based SMR strategies and explain potential discrepancies between current evidence and clinical practice. The aim of this study was to assess the knowledge, perceptions, and reported practices regarding the use of immobilization devices, with particular focus on the vacuum mattress, among prehospital providers operating within a regional emergency medical system.

Materials and Methods

Study design and participants

A cross-sectional observational survey was conducted to assess the knowledge and reported practices regarding the use of the vacuum mattress in prehospital trauma care among healthcare professionals involved in EMS. The study was carried out within the prehospital emergency system of Azienda USL Toscana Centro, one of the largest regional emergency service providers in central Italy. The Italian prehospital emergency medical system is organized at a regional level, resulting in variability in workforce composition and operational models across the country. Within the EMS system of Tuscany, prehospital emergency response is provided through a combination of healthcare professionals and volunteer-based emergency organizations integrated into the regional 118 network. In this context, advanced rescuers are volunteer emergency responders who have completed specific training programs delivered by accredited emergency organizations and have obtained certification allowing them to participate in prehospital emergency ambulance operations within the regional EMS system. Following theoretical and practical training, including supervised field experience, they are authorized to perform predefined emergency care activities according to regional protocols and under the organizational framework of the EMS network. Two professional groups involved in prehospital emergency care were targeted: EMS nurses working within the regional 118 prehospital emergency system and advanced rescuers operating in volunteer-based emergency organizations integrated within the same EMS network. Participants were eligible if they were actively involved in prehospital emergency response and had professional roles requiring the use of immobilization devices during trauma management. Individuals were included if they were EMS nurses or certified advanced rescuers working within the regional prehospital emergency system and provided informed consent to participate in the study. Participants who were not actively involved in prehospital emergency activities or who did not provide consent were excluded.

Survey development and data collection

A structured questionnaire was developed to investigate participants' knowledge and reported practices regarding the use of the vacuum mattress in prehospital trauma care. The questionnaire was developed by the study team based on current regional prehospital trauma management protocols and the available scientific literature on spinal motion restriction and immobilization practices. The questionnaire consisted of 15 single-response multiple-choice items organized into two sections addressing demographic and professional characteristics as well as knowledge and practical aspects related to the use of immobilization devices in trauma management. The complete questionnaire is provided as Supplementary Material 1 and corresponds to the version used for data collection. Prior to dissemination, authorization to conduct and distribute the survey was obtained from the Task Force of the Department of Nursing and Midwifery Care (DAIO) of Azienda USL Toscana Centro. Participation was voluntary and anonymous, and completion of the questionnaire was considered indicative of informed consent to participate. The survey was disseminated through institutional communication channels within the prehospital emergency service. EMS nurses received the questionnaire via internal email communication, while volunteer-based emergency organizations distributed the survey link among advanced rescuers through their internal communication networks. Responses were collected anonymously.

Statistical analysis

Survey responses were exported and analyzed using Jamovi. Descriptive statistics were used to summarize participants' demographic and professional characteristics as well as their responses to the questionnaire. Results were presented using tables and graphical representations to illustrate the distribution of responses within the study sample.

Results

Participant characteristics

A total of 86 prehospital professionals completed the survey. The majority of respondents were advanced rescuers (77.9%), while 22.1% were EMS nurses. Regarding professional experience, 32.6% of participants reported 1–5 years of service, 24.4% had 6–10 years, 29.1% had 11–20 years, and 14% reported more than 20 years of experience. Participant characteristics are summarized in Table 1.

Knowledge and decision-making in trauma immobilization

Most respondents reported that they would use a vacuum mattress for suspected pelvic fracture in the absence of other devices (87.2%), while 12.8% indicated they would not adopt this strategy. Similarly, 75.6% of participants reported that they would use a spine board in the same clinical scenario.

When asked about the most appropriate immobilization strategy in suspected cranial or spinal trauma, responses were almost evenly distributed between cervical collar combined with spine board (48.8%) and cervical collar combined with vacuum mattress (47.7%), while only a small proportion of respondents selected alternative strategies. In a thoracic trauma scenario, 54.7% of respondents reported that they would use a spine board, whereas 45.3% indicated they would avoid this device. Considerable variability also emerged in the management of minor trauma scenarios. In the case of a patient presenting after a fall from less than one meter without pain, 37.2% of respondents reported they would apply only a cervical collar, 31.4% would use no immobilization device, and 27.9% would use a spine board, while only 3.5% selected the vacuum mattress. Detailed responses are reported in Table 2.

Perceptions and use of immobilization devices

Participants' perceptions regarding immobilization devices revealed a clear distinction between speed and perceived effectiveness. The spine board was perceived as the fastest device for immobilization by 82.6% of respondents, whereas the vacuum mattress was perceived by 74.4% of participants as the most effective device for patient stabilization. Despite this perceived effectiveness, the vacuum mattress appeared to be infrequently used in clinical practice. Most respondents (94.2%) reported using the device fewer than five times per year, while only a small proportion indicated more frequent use. These findings are summarized in Table 3.

Table 1. Participant characteristics (n = 86).

Characteristic	n	%
Professional role		
Advanced rescuer	67	77.9
EMS nurse	19	22.1
Years of service		
1- years	28	32.6
6-10 years	21	24.4
11-20 years	25	29.1
>20 years	12	14

Table 2. Knowledge, clinical decisions and perceptions regarding spinal immobilization devices.

Survey item	Response	n	%
Use of vacuum mattress for suspected pelvic fracture (no other devices available)	Yes	75	87.2
	No	11	12.8
Use of spine board for suspected pelvic fracture	Yes	65	75.6
	No	21	24.4
Spine immobilization strategy for suspected cranial/spinal trauma	Cervical collar + spine board	42	48.8
	Cervical collar + vacuum mattress	41	47.7
	Other strategies	3	3.5
Use of spine board in thoracic trauma	Yes	47	54.7
	No	39	45.3
Management of fall <1 m without pain	Spine board	24	27.9
	Cervical collar only	32	37.2
	Vacuum mattress	3	3.5
Perceived fastest immobilization device	No immobilization device	27	31.4
	Spine board	71	82.6
	Vacuum mattress	15	17.4
Perceived most effective device	Vacuum mattress	64	74.4
	Spine board	22	25.6
Frequency of vacuum mattress use per year	0–5 times	81	94.2
	6–10 times	4	4.7
	>10 times	1	1.1

Discussion

The present study explored prehospital providers' knowledge, perceptions, and practices regarding spinal immobilization devices, with particular focus on the use of the vacuum mattress. Our findings reveal a discrepancy between participants' perceived effectiveness of immobilization devices and their actual clinical use. While most participants perceived the vacuum mattress the most effective immobilization device, the spine board was perceived as faster to apply and remained more commonly used in clinical practice. Moreover, the vacuum mattress was reported to be used only rarely by most providers.

This perception–practice gap suggests that operational factors such as application speed, familiarity with traditional devices, and logistical considerations may continue to influence immobilization practices despite evolving evidence and recommendations supporting selective SMR. These findings should be interpreted in the context of the ongoing transition from routine spinal immobilization toward selective SMR. The practice of spinal immobilization has historically been considered a standard component of trauma care, particularly in prehospital settings. However, the widespread use of rigid cervical collars and spine boards was largely adopted before robust clinical evidence was available. More recent analyses have highlighted the limited high-level evidence supporting routine immobilization and have emphasized the potential complications associated with prolonged spine board use, including discomfort, pressure injuries, and respiratory compromise.[8] The routine use of the spine board in prehospital trauma care originated in the early 1970s and was largely based on expert consensus and mechanism-of-injury criteria rather than robust clinical evidence.[9] Over the last decade, significant changes in prehospital trauma care have shifted the paradigm from routine spinal immobilization toward selective SMR. Recent narrative and evidence syntheses have emphasized that immobilization strategies should be tailored to patient risk, minimizing unnecessary device use while preserving spinal protection when clinically indicated.[3] Current recommendations limit the use of spine boards primarily to extrication purposes or to patients with clear neurological deficits or high-risk mechanisms. Importantly, no cases of spinal paralysis were observed among patients who were not immobilized, supporting the safety of more selective immobilization strategies. Previous literature has questioned the clinical benefit of routine spinal immobilization and reported that prehospital immobilization does not consistently improve neurological or functional outcomes while potentially exposing patients to complications such as respiratory impairment, increased intracranial pressure, pain, and pressure ulcers.[10,11] Similarly, narrative reviews have highlighted the limited clinical benefit of rigid spine boards and described several adverse effects associated with their prolonged use.[12] Traditional immobilization techniques have also been criticized for potentially redistributing mechanical forces along the spine and complicating airway management, raising concerns about their overall benefit in trauma patients.[13] Together, these findings support the ongoing transition toward selective spinal motion restriction strategies. The implementation of SMR protocols has been associated with a substantial reduction in spine board utilization without increasing the incidence of spinal cord injury among trauma patients.[11] Likewise, educational interventions focused on SMR have significantly reduced backboard use, with some EMS systems reporting reductions of nearly 60% following targeted training programs.[14] These findings suggest that training and protocol implementation may play a key role in aligning clinical practice with current evidence-based recommendations. Despite these evolving recommendations, the optimal device for SMR remains a matter of debate.

Table 3. Perceptions and use of spinal immobilization devices.

Device	Fastest (%)	Most effective (%)
Spine board	82.6	25.6
Vacuum mattress	17.4	74.4

Biomechanical studies comparing immobilization devices have produced heterogeneous results. For example, Nolte *et al.* used motion-tracking sensors to quantify cervical spine movement during ambulance transport and reported that immobilization with a spine board combined with head blocks and straps resulted in the lowest cervical motion scores, whereas the use of a vacuum mattress was associated with greater measured motion. Interestingly, the addition of a cervical collar did not significantly improve motion restriction when head blocks and straps were already applied. These findings suggest that device performance depends not only on the type of device but also on its overall configuration and the clinical context in which it is applied. Other experimental and clinical studies have raised questions about the biomechanical performance of the spine board during transport. In a randomized crossover trial involving healthy volunteers, patients immobilized on a stretcher mattress demonstrated significantly less lateral movement compared with those secured to a spine board, suggesting that traditional immobilization devices may not always provide optimal motion restriction during ambulance transport.[15] However, evidence remains heterogeneous. In a randomized clinical trial comparing a long backboard with a vacuum mattress splint in trauma patients, the long backboard was reported to be faster to apply and associated with favorable immobilization scores and higher patient comfort during prehospital management.[16] These findings help explain the discrepancy observed in our study between participants' perceptions of device effectiveness and the actual clinical use of immobilization devices. Although most participants perceived the vacuum mattress as the most effective immobilization method, the spine board was perceived as faster to apply and therefore remained more commonly used in clinical practice. In time-critical prehospital environments, factors such as speed of application, ease of use, and provider familiarity may influence device selection as much as perceived device effectiveness. This may explain why traditional devices continue to be widely used despite growing evidence supporting more selective and patient-centered SMR strategies.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the survey was conducted within a single regional prehospital emergency system in central Italy, which may limit the generalizability of the results to other EMS settings with different organizational structures, training models, or operational protocols. However, Azienda USL Toscana Centro represents one of the largest prehospital emergency systems in Italy and includes both professional EMS nurses and volunteer-based advanced rescuers, reflecting a broad spectrum of providers involved in prehospital trauma care. Second, the study relied on self-reported responses regarding clinical decision-making and device use. As with most survey-based research, reported practices may not perfectly reflect real-world clinical behavior. Participants may also have been influenced by recall bias or by the tendency to provide responses perceived as consistent with recommended practice. Third, participation in the survey was voluntary, and therefore a degree of selection bias cannot be excluded. Healthcare professionals with a particular interest in trauma care or immobi-

lization practices may have been more likely to participate. Moreover, because the total number of professionals who received the survey invitation was not available, the response rate could not be calculated. Consequently, the representativeness of the respondents relative to the wider population of prehospital providers cannot be fully assessed. Furthermore, advanced rescuers represented the majority of the study sample (77.9%). Therefore, the findings may predominantly reflect the perceptions and reported practices of this professional group and should be interpreted with caution when generalizing the results to the broader population of prehospital providers. Additionally, the questionnaire did not provide an operational definition of the term "effectiveness." Consequently, respondents may have interpreted it according to different criteria, including spinal motion restriction, patient comfort, safety, ease of application, or overall clinical usefulness.

Conclusions

This study provides insight into prehospital providers' knowledge, perceptions, and reported practices regarding the use of immobilization devices in trauma care, with particular attention to the vacuum mattress. Although the vacuum mattress was widely perceived as the most effective device for patient stabilization, it appeared to be used only rarely in clinical practice. In contrast, the spine board was perceived as faster to apply and remained commonly used in the prehospital setting. These findings highlight a discrepancy between participants' perceptions of device effectiveness and the actual clinical use of spinal immobilization devices. In time-critical prehospital environments, operational factors such as speed of application, provider familiarity, and organizational practices may strongly influence device selection. Improving training, standardizing protocols, and aligning clinical practice with evolving evidence on SMR may contribute to more consistent and evidence-informed trauma care in the prehospital setting.

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Online supplementary materials.

A questionnaire aimed at 118 nurses and advanced-level paramedics who work in the Empolese-Val d'Elsa area, with the aim of gathering information regarding their knowledge of the use of immobilisation devices on trauma patients (Italian)
Questionario rivolto agli Infermieri del 118 e soccorritori di livello avanzato che svolgono servizio nelle aree dell'empolese - val d'elsa, con lo scopo di raccogliere informazioni, in merito alle conoscenze sull' utilizzo dei presidi d'immobilizzazione sul paziente traumatico

Contributions: Lorenzo Galli, Leonardo Ceccanti and Ilario Bocchi conceived the study. Lorenzo Galli and Leonardo Ceccanti conducted data collection and statistical analysis. Leonardo Ceccanti contributed to study design refinement and manuscript drafting and revision. Flavio Gheri drafted the original manuscript. All authors critically reviewed and approved the final manuscript.

Conflict of interest: the authors declare no conflict of interest.

Ethical approval: the study was conducted in accordance with the Declaration of Helsinki and received formal authorization from the Director of the Department of Nursing and Midwifery Care of Azienda USL Toscana Centro. According to local institutional regulations, formal Ethics Committee approval was not required as no identifiable or sensitive personal data were collected.

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Efficacia dei dispositivi di controllo automatico della FiO_2 in terapia intensiva neonatale: una revisione della letteratura

Effectiveness of automatic FiO_2 control devices in the neonatal intensive care unit: a literature review

Giovanni Lorenzo Scotto,[1] Verena Meran,[2] Anna Bizzarri,[3] Angelica Delli Compagni[1]

[1]Infermiere di Terapia Intensiva Neonatale, Ospedale Maggiore, Bologna; [2]Infermiere dell'Unità di Accoglienza e Osservazione a Breve Termine del pronto soccorso, Ospedale di Bolzano, Bolzano; [3]Infermiere dell'Unità di Terapia Intensiva Pediatrica, Ospedale Sant'Orsola, Bologna, Italia

RIASSUNTO

Introduzione: l'insufficienza respiratoria nel neonato richiede frequentemente supporto con ossigenoterapia quale intervento fondamentale. L'utilizzo di elevate concentrazioni di ossigeno espone però il neonato ad elevato stress ossidativo ed allo sviluppo di numerose patologie croniche. L'articolo si propone di sintetizzare la letteratura scientifica sulla reale efficacia di strumenti di gestione automatica della FiO_2 erogata, in particolare la reale efficacia di questa tecnologia di mantenere il paziente all'interno di target di saturazione predefiniti, riducendo i periodi di iperossia o ipossia.
Materiali e Metodi: è stata eseguita una revisione della letteratura attraverso le banche dati online di Medline per Pubmed, Cochrane Library e EBSCO per CINAHL, sono stati esclusi gli articoli che trattavano esiti diversi rispetto ai criteri di efficacia dell'obiettivo di ricerca, sono stati selezionati solo articoli in lingua inglese che fossero stati pubblicati negli ultimi 10 anni.
Risultati: dalla letteratura si evidenzia che l'utilizzo di dispositivi per la titolazione automatica della FiO_2, nei neonati sottoposti ad ossigenoterapia, ha aumentato il tempo passato all'interno del target di saturazione impostato, riducendo i periodi di ipossia o iperossia.
Conclusioni: dalla revisione emerge l'efficacia dei dispositivi automatici (Closed-Loop Automated Oxygen Control, CLAC). Sono necessari ulteriori studi affinché venga individuato un range target ottimale di saturazione, in modo da poter guidare correttamente la pratica clinica nella somministrazione di ossigeno. Sebbene l'utilizzo di CLAC si sia dimostrato efficace nel mantenimento dei normali target di saturazione, sono necessari ulteriori studi di follow-up per dimostrare che l'utilizzo di CLAC sia realmente efficace per ridurre le patologie correlate ad iperossia.

Parole chiave: insufficienza respiratoria neonatale; ossigenoterapia; sistemi di controllo automatico della FiO_2.

ABSTRACT

Introduction: respiratory failure in newborns frequently requires oxygen therapy as a fundamental intervention. However, the use of high concentrations of oxygen exposes the newborn to high oxidative stress and increases the risk of developing numerous chronic conditions. This article aims to summarize the scientific literature on the actual effectiveness of devices for the automatic management of delivered FiO_2, specifically the actual effectiveness of this technology in maintaining the patient within predefined saturation targets while reducing periods of hyperoxia or hypoxia.
Materials and Methods: a literature review was conducted using the online databases Medline (for PubMed), the Cochrane Library, and EBSCO (for CINAHL). Articles addressing outcomes other than the efficacy criteria of the research objective were excluded; only English-language articles published within the last 10 years were selected.
Results: the literature indicates that the use of devices for automatic FiO_2 titration in newborns receiving oxygen therapy increased the time spent within the set saturation target range, thereby reducing periods of hypoxia or hyperoxia.
Conclusions: this review demonstrates the effectiveness of automatic devices (Closed-Loop Automated Oxygen Control, CLAC). Further studies are needed to identify an optimal target saturation range, in order to properly guide clinical practice in oxygen administration. Although the use of CLAC has been shown to be effective in maintaining normal saturation targets, further follow-up studies are needed to demonstrate that the use of CLAC is truly effective in reducing hyperoxia-related complications.

Key words: neonatal respiratory failure; oxygen therapy, Closed-Loop Automated Oxygen Control (CLAC).

Corrispondente: Giovanni Lorenzo Scotto, Infermiere di Terapia Intensiva Neonatale, Ospedale Maggiore, Bologna, Italia.
E-mail: giovannilorenzo.scotto@ausl.bologna.it

Introduzione

L'ossigenoterapia prevede la somministrazione di concentrazioni di ossigeno superiori rispetto a quella presente in aria ambiente (0,21). Nei neonati e nei neonati prematuri, l'ossigenoterapia ha lo scopo di fornire ossigeno sufficiente ai tessuti in modo da evitare il metabolismo anaerobico e di promuovere uno sviluppo ottimale. L'ipossia perinatale rappresenta una delle maggiori minacce per il neonato, per questo motivo, nei primi minuti di vita e durante la degenza in Terapia Intensiva Neonatale (TIN), molti neonati sono sottoposti ad ossigenoterapia.[1]

È importante considerare, però, che concentrazioni troppo elevate di ossigeno potrebbero avere conseguenze molto gravi, quali stress ossidativo e problematiche a organi ed apparati, in particolar modo polmone, sistema nervoso centrale ed apparato visivo.[2]

L'obiettivo clinico assistenziale risulta dunque quello di trovare il giusto bilanciamento tra somministrare ossigeno in quantità inferiori o in quantità superiori al necessario. Questo si traduce, nella pratica clinica, nel cercare di evitare e/o prevenire le condizioni di ipossia e di iperossia.[3]

Per cercare di ridurre il danno da iperossia, esistono diverse strategie. Tra queste, è possibile misurare la saturazione (SpO_2) mediante pulsossimetria e regolare conseguentemente la FiO_2, ovvero la quantità di ossigeno inspirata, tenendo conto del valore di saturazione che si desidera ottenere. I neonati e i neonati prematuri, però, a causa dell'elevata instabilità respiratoria, sono soggetti a frequenti fluttuazioni della saturazione arteriosa, con conseguente difficoltà nel mantenere, da parte dell'operatore, la saturazione di ossigeno all'interno dell'intervallo target per evitare al neonato l'esposizione a ipossia o iperossia.

Per gestire queste problematiche, sono stati sviluppati dei sistemi di controllo automatico dell'ossigeno a circuito chiuso (Closed-Loop Automated Oxygen Control, CLAC), i quali permettono di monitorare, attraverso pulsossimetro, i valori sanguigni di saturazione in tempo reale e, di conseguenza, regolare tempestivamente e automaticamente la FiO_2 somministrata al neonato grazie ad un algoritmo.[4] In questo modo non vi è necessità di intervento da parte del personale sanitario. Esistono diversi sistemi di gestione automatica della FiO_2: a seconda della casa costruttrice del ventilatore meccanico neonatale, il sistema cambia nome ed algoritmo di funzionamento. Non è scopo di questa revisione analizzarli e confrontarli: l'obiettivo dello studio è sintetizzare la letteratura in merito alla capacità di tali dispositivi di mantenere il neonato all'interno di un determinato target di saturimetria, rispetto alla gestione manuale degli operatori.

Materiali e Metodi

Per rispondere al quesito di ricerca è stata condotta una revisione integrativa della letteratura consultando la banca dati MEDLINE (attraverso PubMed), Cochrane e CINAHL (attraverso EBSCO), nel periodo compreso tra 01/12/2024 e 30/01/2025 ed aggiornata nel mese di settembre 2025. La ricerca ha come limiti la lingua inglese e come limite temporale gli ultimi 10 anni.

La strategia di ricerca ha utilizzato i termini: newborn AND automated control of oxygen therapy, newborn AND automated control of oxygen therapy AND desaturation. Inizialmente, è stata condotta una ricerca bibliografica attraverso database elettronici, identificando tutti gli articoli potenzialmente rilevanti per gli obiettivi della revisione. Dopo aver rimosso i titoli duplicati e quelli non pertinenti sono state avviate due fasi principali: l'estrazione e la sintesi dei dati. Sono stati rimossi gli studi che valutavano il livello di ossigenazione al livello di un solo apparato e quelli che prevedevano la somministrazione di ossigeno solo attraverso un'unica strategia ventilatoria (Figura 1). L'analisi approfondita degli studi è stata realizzata tramite un processo interattivo di lettura continua e analisi dei contenuti. Successivamente, i dati sono stati aggregati utilizzando un approccio tematico per identificare i principali temi presenti in tutti gli studi, prendendo in considerazione solo quelli che valutavano la riduzione del tempo trascorso in iperossia o ipossia e quindi la durata del tempo trascorso all'interno dei target stabiliti. I risultati sono stati presentati poi in una sintesi descrittiva dei risultati emersi dalla revisione.

Risultati

La letteratura analizzata comprende studi randomizzati controllati, trial crossover, studi osservazionali prospettici e revisioni sistematiche con metanalisi condotti prevalentemente in unità di terapia intensiva neonatale europee, nord-americane e australiane, includendo neonati pretermine sottoposti sia a ventilazione invasiva sia a supporto respiratorio non invasivo.[1,4-6,-9,10,,13,14-20]

Complessivamente, gli studi inclusi hanno valutato l'efficacia dei sistemi di controllo automatico della FiO_2 (Closed-Loop Automated Control, CLAC) confrontandoli con la titolazione manuale dell'ossigenoterapia. Gli outcome maggiormente analizzati riguardavano la percentuale di tempo trascorso all'interno dell'intervallo target di saturazione, nonché la frequenza e la durata degli episodi di ipossiemia e iperossiemia.

Nel complesso, l'utilizzo dei sistemi CLAC è risultato associato a un significativo incremento del tempo trascorso all'interno del range target di SpO_2 rispetto alla regolazione manuale, con un miglioramento medio compreso tra il 20% e il 25% nei diversi studi analizzati.[7-9,15,16] Tale beneficio è stato osservato indipendentemente dalla modalità di ventilazione utilizzata e nelle diverse età postnatali.[5,7,8]

Parallelamente, numerosi studi hanno documentato una riduzione sia della frequenza sia della durata degli episodi di desaturazione e iperossiemia durante l'impiego del controllo automatizzato.[1,8,9,17] La maggiore rapidità di risposta dei sistemi automatici alle variazioni della SpO_2 consente infatti una correzione più tempestiva delle fluttuazioni dell'ossigenazione, limitando il tempo trascorso fuori dal range target.

Alcuni studi hanno segnalato occasionali episodi residui di ipossiemia o iperossiemia anche durante il controllo automatizzato; tuttavia, tali eventi risultavano generalmente di durata inferiore rispetto alla titolazione manuale.[15] È inoltre emerso che i sistemi CLAC non modificano l'instabilità respiratoria intrinseca del neonato prematuro, ma migliorano significativamente la gestione delle variazioni di ossigenazione.

Un ulteriore risultato condiviso tra gli studi riguarda la riduzione del carico di lavoro del personale sanitario. Durante il controllo automatizzato si osserva infatti una marcata diminuzione degli interventi manuali di regolazione della FiO□, con riduzioni fino al 90% delle modifiche effettuate dagli operatori rispetto alla gestione manuale.[9]

Nel complesso, le evidenze disponibili indicano che i sistemi automatizzati di controllo dell'ossigenoterapia consentono un migliore mantenimento dei valori di saturazione entro i limiti target, riducendo l'esposizione a ipossia e iperossia e ottimizzando contemporaneamente l'impiego delle risorse assistenziali.

Discussione

Dalla letteratura si evidenzia che l'utilizzo di CLAC ha incrementato la quantità di tempo che il neonato trascorre all'interno del target di saturazione impostato, riducendo periodi di ipossia o iperossia.

È stato inoltre dimostrato che la conformità a valori di satura-

zione entro il target è direttamente proporzionale al rapporto infermiere/neonato, riducendosi al diminuire del suddetto rapporto nelle TIN. Infatti, la percentuale di tempo trascorsa con SpO_2 all'interno del range target si è ridotta dal 38% al 15% con un rapporto infermiere/neonato di 1:1, rispetto a rapporti infermiere/neonato di 1:3 o inferiori.[11] L'automazione, invece, rende possibili regolazioni della FiO_2 molto più frequenti di quanto sia possibile manualmente durante le cure di routine, con costante attenzione e rapidità di risposta 24 ore al giorno. Le evidenze suggeriscono quindi che la titolazione automatizzata dell'ossigeno erogato possa ridurre significativamente il carico di lavoro degli infermieri di Terapia Intensiva Neonatale.[2]

Tra gli autori è però comune un'obiezione all'utilizzo dei sistemi CLAC: il sistema automatizzato potrebbe potenzialmente mascherare un aumento del fabbisogno di ossigeno del prematuro, mantenendo i valori di saturazione nel target aumentando la FiO_2 erogata senza che gli operatori sanitari ne abbiano consapevolezza immediata.[1] La risoluzione autonoma degli eventi di desaturazione potrebbe infatti nascondere elementi clinici rilevanti, ritardando la diagnosi della causa dell'ipossiemia. Per questo motivo è fondamentale che gli infermieri siano formati al controllo periodico e sistematico dei valori di FiO_2 automaticamente erogati dal sistema. Inoltre, alcuni autori suggeriscono che tali sistemi dispongano di una funzione di allarme aggiuntiva che segnali un aumento significativo medio della FiO_2 anche quando la SpO_2 rimane all'interno dell'intervallo target.[1,2]

Conclusioni

In sintesi, si evidenzia la necessità di condurre ulteriori studi affinché venga individuato un range target ottimale di saturazione. Diverse pubblicazioni, infatti, hanno sottolineato

l'importanza di individuare dei range target di saturazione ade-

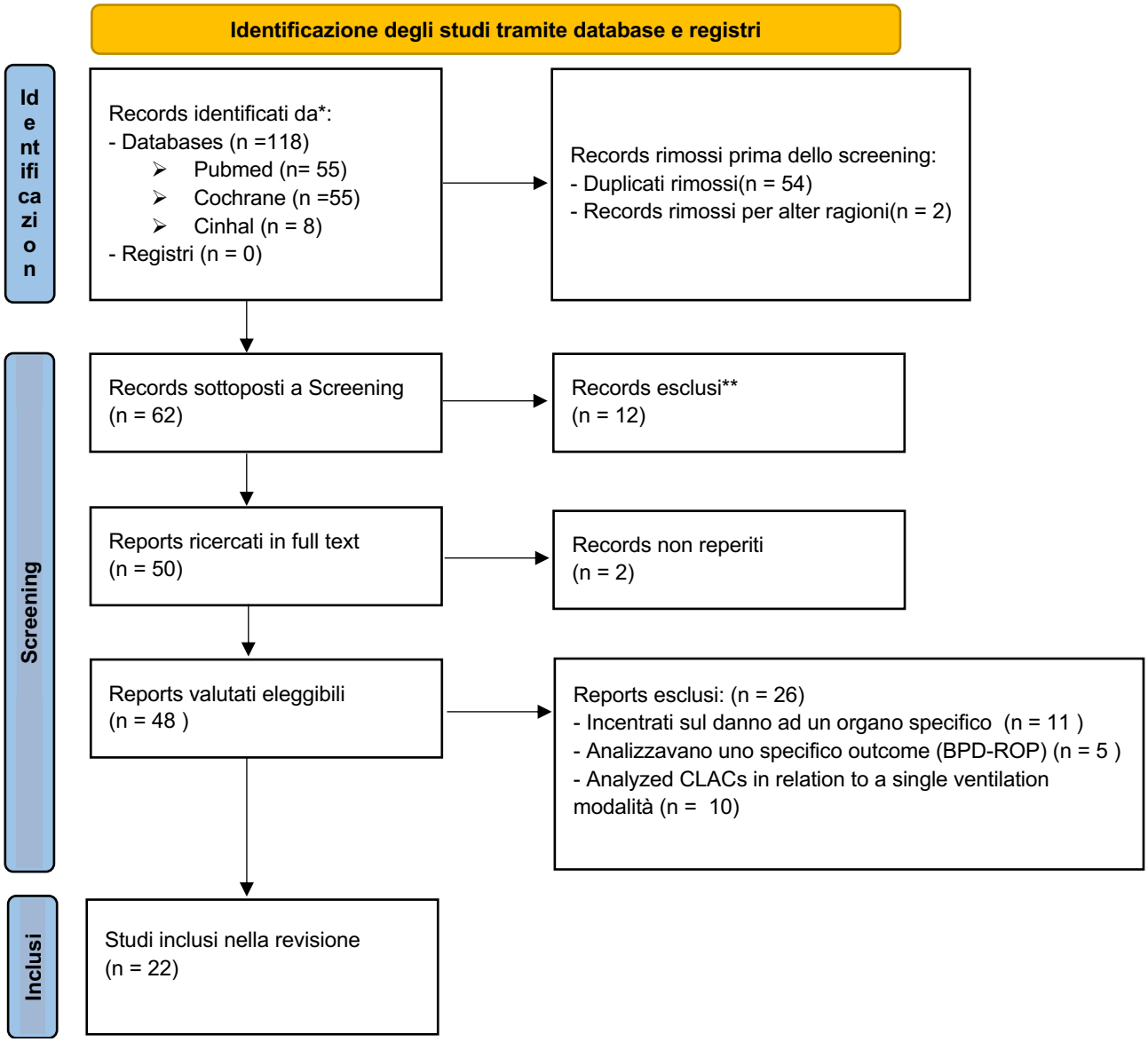


Figura 1. Diagramma Prisma del lavoro.

guati al singolo neonato e applicare dei limiti di allarme precisi sul monitor. Infine, sebbene l'utilizzo di CLAC si sia dimostrato efficace nel mantenimento dei normali target di saturazione, sono necessari ulteriori studi di follow-up per dimostrare che l'utilizzo di CLAC sia realmente efficace per ridurre le patologie correlate ad iperossia a lungo termine.[18-22]

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Materiali supplementary online
Tabella 1. Studi considerati.

Contributi: Giovanni Lorenzo Scotto, ideatore del progetto, ha curato le fasi di ricerca e la selezione degli articoli, ha curato la struttura del testo per rispondere al meglio al quesito di ricerca; Verena Meran, ricerca e lettura critica degli articoli selezionati e compilazione della tabella di sintesi; Anna Bizzarri, scrittura del paragrafo relativo ai risultati, partendo dalla tabella di sintesi e proseguendo con approfondimenti sui singoli articoli selezionati. contributo nella rilettura del testo; Angelica Delli Compagni, ha curato la flow chart del metodo Prisma ed ha revisionato la scrittura del testo.

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Valutazione delle conoscenze infermieristiche sulla gestione preospedaliera e ospedaliera dello shock ipovolemico da trauma: studio osservazionale nazionale

Luca Roberto,[1] Fabrizio Pignatta,[2] Yari Barnabino[4,5]

[1]Infermiere, Ospedale Sant'Andrea, ASL Vercelli; [2]Infermiere, Servizio di Emergenza Sanitaria (EMS) 118, A.O.U. Città della Salute e della Scienza, Torino; [3]Direttore nazionale, Programma ATCN; [4]Infermiere, MSc, Servizio di Emergenza Sanitaria (EMS) 118, Ospedale Universitario "Maggiore della Carità", Novara; [5]Professore a contratto, Facoltà di Medicina, Università del Piemonte Orientale, Novara, Italia

RIASSUNTO

Introduzione: lo shock ipovolemico da trauma rappresenta una delle principali cause di mortalità prevenibile nel trauma maggiore. La gestione si basa su strategie di rianimazione controllata e richiede un approccio tempo-dipendente integrato tra setting preospedaliero e ospedaliero. L'infermiere svolge un ruolo centrale nel riconoscimento precoce e nella gestione iniziale del paziente. Obiettivo dello studio è di valutare il livello di conoscenze infermieristiche nella gestione dello shock ipovolemico da trauma ed esplorare l'associazione tra formazione recente sul trauma, disponibilità di algoritmi clinico-assistenziali e performance nei casi clinici.

Materiali e metodi: studio osservazionale trasversale nazionale (1-31 luglio 2025) su 170 infermieri iscritti ad ANIARTI (Associazione Nazionale Infermieri di Area Critica). È stato utilizzato un questionario *ad hoc* validato a contenuto (S-CVI=0,95), composto da dati socio-demografici, informazioni su formazione e disponibilità di algoritmi e sei casi clinici. Sono state effettuate analisi descrittive e confronti bivariati mediante test t di Welch.

Risultati: il punteggio medio complessivo è risultato pari a 3,12/6 (52%). Le percentuali di risposte corrette variavano dall'83% al 49% nei diversi casi clinici. I partecipanti con formazione recente presentavano punteggi medi superiori rispetto ai non formati (3,60 *vs* 1,96). Punteggi mediamente più elevati si osservavano nei contesti dotati di algoritmi clinico-assistenziali integrati.

Conclusioni: le conoscenze infermieristiche relative alla gestione dello shock ipovolemico da trauma sono risultate complessivamente moderate. I risultati suggeriscono una possibile associazione tra formazione recente, disponibilità di strumenti organizzativi strutturati e migliori performance nei casi clinici. L'implementazione di programmi formativi periodici e algoritmi clinico-assistenziali integrati potrebbe contribuire a migliorare l'omogeneità delle pratiche assistenziali e supportare la sicurezza del paziente nei setting di emergenza.

Parole chiave: shock emorragico; ferite e lesioni; ipotensione permissiva; assistenza infermieristica; servizi medici di emergenza.

Corrispondente: Luca Roberto, Infermiere, Ospedale Sant'Andrea, ASL Vercelli, Vercelli, Italia.
Italia. E-mail: lucaroberto00@gmail.com

Introduzione

Lo shock ipovolemico da trauma è caratterizzato da una riduzione critica della perfusione tissutale secondaria a una perdita ematica acuta ed è riconosciuto come una delle principali cause di mortalità prevenibile nel trauma maggiore.[1,2] Il trauma rappresenta la terza causa di morte nei Paesi occidentali e la principale causa di mortalità nella popolazione al di sotto dei 40 anni.[2] Negli Stati Uniti, circa il 40% dei decessi traumatici è attribuibile all'emorragia, che rimane la principale causa prevenibile di morte correlata al trauma.[1] In Italia, secondo i più recenti dati ISTAT, nel 2023 si sono verificati oltre 166.000 incidenti stradali con lesioni a persone, causando oltre 3.000 decessi e oltre 224.000 feriti.[3] Negli ultimi anni l'approccio rianimatorio si è progressivamente orientato verso strategie di rianimazione controllata e ipotensione permissiva, con l'obiettivo di limitare l'aggravamento della coagulopatia e favorire il controllo precoce dell'emorragia.[4,5] La gestione del trauma grave è una condizione fortemente tempo-dipendente e richiede una stretta integrazione tra setting preospedaliero e ospedaliero, in particolare nella fase corrispondente alla cosiddetta "*golden hour*", durante la quale la tempestività delle cure risulta determinante per la sopravvivenza del paziente.[6] In questo contesto l'infermiere svolge un ruolo determinante nel riconoscimento precoce dello shock, nell'esecuzione degli interventi prioritari, nel monitoraggio dei parametri vitali e nel coordinamento del team durante le fasi iniziali di trattamento.[7,8] Nonostante la rilevanza del ruolo infermieristico, risultano limitati i dati nazionali relativi al livello di conoscenze nella gestione dello shock ipovolemico da trauma e all'impatto di formazione specifica e strumenti organizzativi sulle competenze decisionali, in particolare per quanto riguarda l'adozione di algoritmi clinico-assistenziali strutturati.[9,10]

Materiali e Metodi

È stato condotto uno studio osservazionale trasversale nazionale nel periodo compreso tra il 1° e il 31 luglio 2025, in conformità con le linee guida STROBE per gli studi osservazionali. La popolazione in studio era costituita da infermieri iscritti ad ANIARTI operanti nel setting preospedaliero e nei Dipartimenti di Emergenza-Accettazione. Il questionario è stato diffuso tramite mailing list e canali ufficiali ANIARTI. Lo strumento di rilevazione consisteva in un questionario sviluppato *ad hoc,* composto da sedici quesiti a risposta multipla suddivisi in tre sezioni: dati sociodemografici e professionali, informazioni relative alla formazione sul trauma e alla disponibilità di algoritmi clinico-assistenziali regionali, e sei casi clinici focalizzati sulla gestione dello shock ipovolemico da trauma nei setting preospedaliero e ospedaliero. I sei casi clinici sono stati progettati per valutare le conoscenze relative alla gestione iniziale del paziente con trauma e shock ipovolemico. Gli scenari affrontavano differenti aspetti del percorso assistenziale, comprendendo il riconoscimento precoce dello stato di shock, la valutazione primaria secondo l'approccio ABCDE, le priorità assistenziali, le strategie di rianimazione iniziale e l'applicazione dei principi raccomandati dalle principali linee guida internazionali sul trauma. Per ciascun caso era prevista una sola risposta corretta, definita a priori sulla base delle evidenze scientifiche disponibili e delle linee guida utilizzate per la costruzione del questionario. A ogni risposta corretta veniva assegnato un punto, mentre alle risposte errate venivano assegnati zero punti, ottenendo un punteggio complessivo compreso tra 0 e 6, successivamente utilizzato come misura continua del livello di conoscenza dei partecipanti. Il questionario completo, comprensivo dei sei casi clinici, è disponibile come *Materiale Supplementare*. Lo sviluppo del questionario è avvenuto con il supporto di due infermieri esperti operanti nell'ambito dell'emergenza territoriale e ospedaliera. La validità di contenuto è stata valutata mediante un panel composto da dieci infermieri esperti nella gestione del trauma in ambito preospedaliero e ospedaliero. Ciascun esperto ha valutato individualmente tutti i sei casi clinici utilizzando una scala Likert a cinque punti, considerando i seguenti criteri: chiarezza e comprensibilità del caso clinico, rilevanza clinica, realismo dello scenario, coerenza delle opzioni di risposta e capacità del quesito di valutare le conoscenze oggetto dello studio. Gli esperti hanno inoltre fornito osservazioni qualitative, successivamente discusse dagli autori e recepite nella versione definitiva del questionario prima della sua somministrazione. La validazione quantitativa è stata effettuata mediante il calcolo dell'Item Content Validity Index (I-CVI) per ciascun item e del Scale Content Validity Index (S-CVI) complessivo, risultato pari a 0,95, indicativo di un'elevata validità di contenuto.[11] Non è stato condotto un pilot test separato, poiché il questionario è stato somministrato esclusivamente dopo il completamento della validazione qualitativa e quantitativa e dopo l'implementazione delle modifiche suggerite dal panel di esperti. Ulteriori proprietà psicometriche, quali affidabilità interna e test-retest, non sono state valutate, in quanto lo strumento è stato sviluppato specificamente per il presente studio osservazionale. La raccolta dei dati è avvenuta in forma anonima e volontaria mediante la piattaforma online Jotform® (Jotform Inc., San Francisco, California, USA), nel rispetto del Regolamento UE 2016/679 (GDPR). L'outcome principale era rappresentato dal punteggio complessivo ottenuto nei sei casi clinici (range 0-6), espresso come numero di risposte corrette. Punteggi più elevati indicavano un maggiore livello di conoscenze relative alla gestione iniziale dello shock ipovolemico da trauma. Le analisi statistiche sono state effettuate mediante Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Le variabili categoriali sono state descritte mediante frequenze assolute e percentuali, mentre i punteggi ottenuti nei casi clinici sono stati sintetizzati mediante media, mediana e deviazione standard. Per ciascun caso clinico è stata inoltre calcolata la percentuale di risposte corrette. Sono stati effettuati confronti esplorativi relativamente alla formazione recente sul trauma e alla disponibilità di algoritmi clinico-assistenziali. In particolare, il confronto tra partecipanti con e senza formazione recente sul trauma è stato effettuato mediante test *t* di Welch per due campioni indipendenti, assumendo varianze non omogenee. Il livello di significatività statistica è stato fissato a $p<0,05$. Considerata la natura osservazionale ed esplorativa dello studio, le associazioni osservate sono state interpretate in termini descrittivi e non sono state formulate inferenze causali. Trattandosi di un'indagine anonima rivolta a professionisti sanitari e priva di raccolta di dati clinici relativi a pazienti, non è stato richiesto il parere del Comitato Etico, secondo la normativa vigente e la prassi locale.

Risultati

Sono stati inclusi nello studio 170 infermieri. Le caratteristiche del campione e i principali risultati sono riportati in Tabella 1. La maggioranza dei partecipanti apparteneva alla fascia d'età 30–40 anni e presentava un'anzianità lavorativa superiore ai cinque anni. Il 60,0% operava in ambito preospedaliero e il 70,0% riferiva di aver partecipato a corsi di formazione sul trauma negli ultimi 24 mesi. La disponibilità di algoritmi clinico-assistenziali risultava eterogenea tra i diversi contesti operativi. Il punteggio medio complessivo ottenuto nei sei casi clinici è risultato pari a 3,12±1,12 su 6 (52%). Le percentuali di risposte corrette variavano dall'83% nel

caso clinico 1 al 49% nel caso clinico 6, evidenziando una progressiva riduzione delle performance all'aumentare della complessità decisionale degli scenari clinici. I partecipanti che avevano frequentato corsi di formazione sul trauma negli ultimi due anni hanno ottenuto punteggi medi significativamente superiori rispetto ai partecipanti non formati (3,61±0,91 *vs* 1,96±0,77 risposte corrette su 6). Il confronto mediante test t di Welch per campioni indipendenti ha evidenziato una differenza statisticamente significativa tra i due gruppi ($t = 12,08$; $p<0,001$), con una differenza media di 1,65 punti (IC95% 1,38-1,92) e una dimensione dell'effetto Cohen's d pari a 1,89. Nei contesti privi di protocolli strutturati si osservavano punteggi medi inferiori rispetto ai contesti nei quali erano disponibili algoritmi clinico-assistenziali. La differenza tra i contesti dotati di algoritmi integrati e quelli caratterizzati dalla presenza del solo algoritmo per il trauma maggiore risultava invece più contenuta.

Discussione

I risultati del presente studio evidenziano un livello di conoscenze infermieristiche complessivamente moderato nella gestione dello shock ipovolemico da trauma. La formazione recente sul trauma rappresentava il principale fattore associato a punteggi più elevati, suggerendo il ruolo centrale dell'aggiornamento continuo nella gestione delle condizioni tempo-dipendenti ad alta complessità assistenziale. Tali risultati appaiono coerenti con la letteratura internazionale, che ha evidenziato come programmi formativi strutturati basati su approcci ATLS®, PHTLS® e simulazione clinica siano associati a un miglioramento delle conoscenze teoriche, della sicurezza decisionale e della gestione iniziale del trauma nei professionisti sanitari. In particolare, Chowdhury *et al.*[12] hanno osservato un incremento significativo delle performance dopo programmi formativi intensivi basati sul protocollo ATLS®, mentre Dehghannezhad *et al.*[13] hanno riportato un miglioramento mantenuto nel tempo dopo percorsi formativi integrati e simulazione clinica. I risultati del presente studio si collocano in linea con tali evidenze, pur nell'ambito di un disegno osservazionale e descrittivo. L'assenza di un'associazione lineare tra anzianità lavorativa e punteggi suggerisce che l'esperienza clinica, se non supportata da un aggiornamento strutturato, non garantisce il mantenimento di conoscenze relative alla gestione del trauma maggiore. Questo dato sottolinea l'importanza di programmi formativi periodici, multidisciplinari e basati su scenari clinici realistici. L'utilizzo di casi clinici standardizzati nel presente studio ha consentito di valutare le conoscenze applicate in situazioni assistenziali verosimili, pur non sostituendo una valutazione diretta delle competenze cliniche nella pratica. Un ulteriore elemento emerso dallo studio riguarda la disponibilità di protocolli clinico-assistenziali. I punteggi medi sono risultati inferiori nei contesti privi di protocolli strutturati, mentre la differenza osservata tra contesti dotati di algoritmi clinico-assistenziali integrati e contesti caratterizzati dalla presenza del solo algoritmo per il trauma maggiore è risultata più contenuta. Considerata la natura osservazionale dello studio, tali risultati non consentono di attribuire un effetto causale alla disponibilità di algoritmi clinico-assistenziali; tuttavia, essi suggeriscono

Tabella 1. Caratteristiche del campione e risultati dello studio (N=170).

Sezione	Variabile	Categoria	N	Valore % (DS)
Caratteristiche del campione	Fascia d'età (anni)	< 30	19	11,2
		30-40	62	36,5
		41-50	54	31,7
		> 50	35	20,6
	Esperienza lavorativa (anni)	< 1	5	2,9
		1-4	30	17,6
		5-10	63	37,0
		> 10	72	42,3
	Area geografica	Nord Italia	134	78,8
		Centro Italia	23	13,5
		Sud Italia	13	7,6
	Setting operativo	Preospedaliero	102	60,0
		Ospedaliero	68	40,0
	Formazione sul trauma negli ultimi 24 mesi	Sì	119	70,0
		No	51	30,0
	Disponibilità di algoritmi clinico - assistenziali regionali	Algoritmo trauma maggiore + algoritmo infermieristico	61	35,9
		Solo algoritmo trauma maggiore	81	47,6
		Assenza di protocolli	28	16,5
Performance nei casi clinici	Caso clinico 1	-	141/170	83
	Caso clinico 2	-	98/170	58
	Caso clinico 3	-	111/170	65
	Caso clinico 4	-	119/170	69
	Caso clinico 5	-	96/170	56
	Caso clinico 6	-	84/170	49
Sezione	**Variabile**	**Categoria**	**N**	**Valore % (DS)**
Analisi comparativa	Formazione sul trauma	Sì	119	3,61 (0,91)
		No	51	1,96 (0,77)
	Algoritmi clinici	Algoritmo trauma maggiore + algoritmo infermieristico	61	3,30 (NA)
		Solo algoritmo trauma maggiore	81	3,21 (NA)
		Assenza protocolli	28	2,46 (NA)

Nota. I dati sono espressi come frequenze assolute e percentuali (%) oppure, ove indicato, come media (DS). NA, non disponibile.

no che la presenza di strumenti organizzativi condivisi possa rappresentare un supporto al processo decisionale infermieristico e favorire una maggiore uniformità dei percorsi assistenziali, in linea con le raccomandazioni nazionali sulla gestione integrata del trauma maggiore.[14]

Tra i principali limiti dello studio devono essere considerati il campionamento di convenienza, il reclutamento esclusivo di infermieri iscritti ad ANIARTI e la distribuzione geografica non omogenea del campione, con prevalenza di partecipanti provenienti dal Nord Italia. Tali elementi possono aver determinato un rischio di bias di selezione e limitano la generalizzabilità dei risultati. Un ulteriore limite riguarda l'utilizzo di un questionario sviluppato ad hoc e sottoposto esclusivamente a validazione di contenuto. Sebbene il valore di S-CVI ottenuto supporti la pertinenza clinica degli item, non sono state effettuate ulteriori valutazioni psicometriche, quali affidabilità interna o riproducibilità, che potranno essere oggetto di studi futuri. Inoltre, l'impiego di casi clinici teorici non consente una valutazione diretta delle competenze pratiche reali, pur permettendo una comparazione standardizzata delle conoscenze decisionali. Infine, la natura osservazionale e trasversale dello studio non consente di formulare inferenze causali tra formazione, disponibilità di protocolli clinico-assistenziali e performance ottenute.

Nel complesso, i risultati suggeriscono che programmi formativi periodici, multidisciplinari e basati su scenari clinici, associati all'implementazione di protocolli e algoritmi clinico-assistenziali condivisi lungo la rete trauma, potrebbero contribuire a migliorare l'uniformità dei percorsi assistenziali e supportare il processo decisionale infermieristico nei diversi setting di emergenza.[15,16]

Conclusioni

Le conoscenze infermieristiche relative alla gestione dello shock ipovolemico da trauma sono risultate complessivamente moderate. I partecipanti che avevano frequentato una formazione recente sul trauma hanno ottenuto punteggi medi superiori, mentre la disponibilità di protocolli e algoritmi clinico-assistenziali è risultata associata a punteggi mediamente più elevati, pur richiedendo un'interpretazione prudente alla luce del disegno osservazionale dello studio. Poiché il questionario utilizzato è stato sviluppato *ad hoc* e sottoposto esclusivamente a validazione di contenuto, i risultati devono essere interpretati come una valutazione esplorativa delle conoscenze infermieristiche ottenute nel campione studiato e non come una misura definitiva delle conoscenze infermieristiche. Considerati i limiti metodologici, i risultati suggeriscono che programmi formativi periodici, multidisciplinari e basati su scenari clinici, associati all'implementazione di protocolli e algoritmi clinico-assistenziali condivisi lungo la rete trauma, potrebbero contribuire a favorire una maggiore uniformità dei percorsi assistenziali e supportare il processo decisionale infermieristico nei setting di emergenza.

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Materiali supplementari online
Questionario utilizzato nello studio

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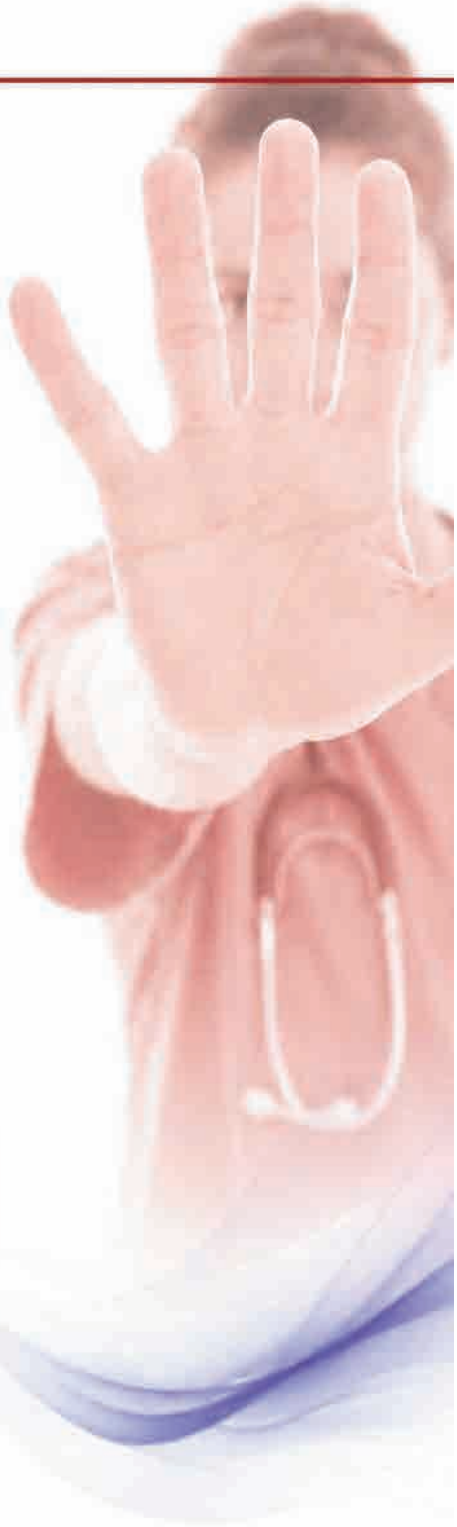
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Nurses' knowledge of prehospital and in-hospital management of traumatic hypovolemic shock: a national observational study

Luca Roberto,[1] Fabrizio Pignatta,[2,3] Yari Barnabino[3]

[1]Registered Nurse, Sant'Andrea Hospital, ASL Vercelli; [2]Registered Nurse, Emergency Medical Services (EMS) 118, A.O.U. Città della Salute e della Scienza, Turin; [3]National Director, ATCN Program; [4]Registered Nurse, MSc, Emergency Medical Services (EMS) 118, University Hospital "Maggiore della Carità", Novara; [5]Adjunct Professor, School of Medicine, University of Eastern Piedmont, Novara, Italy

ABSTRACT

Introduction: traumatic hypovolemic shock is one of the leading causes of preventable death following major trauma. Its management relies on evidence-based resuscitation strategies and requires a time-sensitive, integrated approach across the prehospital and in-hospital settings. Nurses play a pivotal role in the early recognition and initial management of these patients. The objective of the study was to assess nurses' knowledge of traumatic hypovolemic shock management and to explore the association between recent trauma training, the availability of clinical care algorithms, and performance in clinical scenarios.

Materials and Methods: a national cross-sectional observational study was conducted between July 1 and July 31, 2025, among 170 nurses affiliated with ANIARTI (Italian Association of Critical Care Nurses). Data were collected using a purpose-designed questionnaire that underwent content validation (S-CVI = 0.95). The questionnaire included socio-demographic and professional characteristics, information on trauma training and the availability of clinical care algorithms, and six clinical scenarios assessing knowledge of traumatic hypovolemic shock management. Descriptive statistics and bivariate comparisons using Welch's t-test were performed. Results. The mean total knowledge score was 3.12 out of 6 (52%). Correct response rates ranged from 49% to 83% across the six clinical scenarios. Participants who had attended recent trauma training achieved higher mean scores than those without recent training (3.60 *vs* 1.96). Higher mean scores were also observed in settings where integrated clinical care algorithms were available.

Conclusions: nurses' knowledge of traumatic hypovolemic shock management was overall moderate. This exploratory study suggests that recent trauma training and the availability of structured clinical care algorithms may be associated with better performance in clinical scenarios. Given the use of a purpose-designed questionnaire that underwent content validation only, these findings should be interpreted as an exploratory assessment rather than as a definitive measure of nurses' knowledge. Periodic trauma education programmes and the implementation of shared clinical care algorithms may contribute to improving consistency in trauma care and supporting patient safety across emergency settings.

Key words: hemorrhagic shock; wounds and injuries; permissive hypotension; nursing; emergency medical services.

Correspondence: Luca Roberto, Registered Nurse, Sant'Andrea Hospital, ASL Vercelli, Italy. E-mail: lucaroberto00@gmail.com

Introduction

Traumatic hypovolemic shock is characterized by a critical reduction in tissue perfusion resulting from acute blood loss and is recognized as one of the leading causes of preventable death following major trauma.[1,2] Trauma is the third leading cause of death in Western countries and the leading cause of mortality among individuals younger than 40 years.[2] In the United States, approximately 40% of trauma-related deaths are attributable to hemorrhage, which remains the most common preventable cause of death following traumatic injury.[1] In Italy, according to the most recent data released by the Italian National Institute of Statistics (ISTAT), more than 166,000 road traffic accidents involving personal injuries occurred in 2023, resulting in over 3,000 deaths and more than 224,000 injured individuals.[3] Over the past decade, trauma resuscitation has progressively shifted towards damage control resuscitation strategies, including permissive hypotension, with the aim of minimizing trauma-induced coagulopathy and facilitating early haemorrhage control.[4,5] The management of major trauma is inherently time-sensitive and requires close integration between the prehospital and in-hospital settings, particularly during the so-called *golden hour*, when timely recognition and treatment are crucial for improving patient survival.[6] Within this context, nurses play a pivotal role in the early recognition of shock, prioritization of life-saving interventions, continuous monitoring of physiological parameters, and coordination of multidisciplinary team activities during the initial phase of trauma management.[7,8] Despite the importance of nursing practice in trauma care, national evidence regarding nurses' knowledge of traumatic hypovolemic shock management remains limited. In particular, little is known about the relationship between trauma-specific education, the availability of structured clinical care algorithms, and nurses' decision-making abilities in both the prehospital and hospital settings.[9,10]

Materials and Methods

A national cross-sectional observational study was conducted between July 1 and July 31, 2025, in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies. The study population consisted of nurses affiliated with ANIARTI (Italian Association of Critical Care Nurses) working in prehospital emergency medical services and emergency departments. The questionnaire was distributed through the official ANIARTI mailing list and communication channels. Data were collected using a purpose-designed questionnaire consisting of 16 multiple-choice items organized into three sections: socio-demographic and professional characteristics; information regarding trauma education and the availability of regional clinical care algorithms; and six clinical scenarios focused on the management of traumatic hypovolemic shock in both the prehospital and in-hospital settings. The six clinical scenarios were specifically designed to assess participants' knowledge of the initial management of patients with traumatic hypovolemic shock. The scenarios addressed different stages of the clinical pathway, including early recognition of shock, primary assessment according to the ABCDE approach, prioritization of nursing interventions, initial resuscitation strategies, and the application of recommendations from international trauma guidelines. Each scenario included one predefined correct answer established *a priori* according to the available scientific evidence and the international guidelines used during questionnaire development. One point was assigned for each correct answer and zero points for incorrect answers, yielding a total knowledge score ranging from 0 to 6. This score was subsequently treated as a continuous measure of participants' knowledge. The complete questionnaire, including all six clinical scenarios, is provided as *Supplementary Material*. The questionnaire was developed with the support of two expert nurses working in prehospital and emergency care. Content validity was assessed by a panel of ten expert nurses with extensive experience in prehospital and hospital trauma management. Each expert independently evaluated all six clinical scenarios using a five-point Likert scale according to the following criteria: clarity and comprehensibility, clinical relevance, realism of the scenario, consistency of the response options, and the ability of each item to assess the intended knowledge domain. Experts were also invited to provide qualitative comments, which were reviewed by the authors and incorporated into the final version of the questionnaire before its administration. Quantitative content validation was performed by calculating the Item Content Validity Index (I-CVI) for each item and the overall Scale Content Validity Index (S-CVI), which was 0.95, indicating excellent content validity.[11] A separate pilot study was not conducted because the questionnaire was administered only after completion of both the qualitative and quantitative content validation processes and implementation of all modifications suggested by the expert panel. Additional psychometric properties, including internal consistency and test-retest reliability, were not evaluated because the instrument was specifically developed for this observational study. Data were collected anonymously and voluntarily using the online platform Jotform® (Jotform Inc., San Francisco, CA, USA) in accordance with the European Union General Data Protection Regulation (GDPR, Regulation EU 2016/679). The primary outcome was the total score obtained across the six clinical scenarios (range 0–6), expressed as the number of correct responses. Higher scores indicated greater knowledge regarding the initial management of traumatic hypovolemic shock. Statistical analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Categorical variables were summarized using frequencies and percentages, whereas continuous variables were described using the mean, median, and standard deviation. The proportion of correct responses was also calculated for each clinical scenario. Exploratory comparisons were performed according to recent trauma education and the availability of clinical care algorithms. Specifically, differences between participants with and without recent trauma education were assessed using Welch's independent-samples t-test, assuming unequal variances. Statistical significance was established at $p < 0.05$. Given the observational and exploratory nature of the study, all observed associations were interpreted descriptively, and no causal inferences were made. Because the survey was anonymous, involved healthcare professionals only, and did not include the collection of patient data, formal approval by an Ethics Committee was not required according to current Italian regulations and local institutional practice.

Results

A total of 170 nurses were included in the study. The characteristics of the study population and the main findings are summarized in Table 1. Most participants were aged between 30 and 40 years and had more than five years of professional experience. Overall, 60.0% worked in the prehospital setting, while 70.0% reported having attended trauma-related training courses within the previous 24 months. The availability of clinical care algorithms varied across the different clinical settings. The mean total knowledge score across the six clinical scenarios was 3.12 ± 1.12 out of

a maximum of 6 (52%). The proportion of correct responses ranged from 83% for Clinical Scenario 1 to 49% for Clinical Scenario 6, indicating a progressive decline in performance as the decision-making complexity of the scenarios increased. Participants who had attended trauma training within the previous two years achieved significantly higher mean scores than those without recent trauma training (3.61 ± 0.91 vs. 1.96 ± 0.77 correct responses out of six). Comparison using Welch's independent-samples t-test demonstrated a statistically significant difference between the two groups ($t = 12.08$; $p < 0.001$), with a mean difference of 1.65 points (95% CI, 1.38–1.92) and a large effect size (Cohen's $d = 1.89$). Lower mean scores were observed in settings without structured clinical protocols than in those where clinical care algorithms were available. In contrast, the difference between settings with integrated clinical care algorithms and those with only a major trauma algorithm was comparatively small.

Discussion

The present study demonstrated an overall moderate level of nurses' knowledge regarding the management of traumatic hypovolemic shock. Recent trauma education emerged as the factor most strongly associated with higher knowledge scores, highlighting the pivotal role of continuing professional education in the management of time-sensitive and highly complex clinical conditions. These findings are consistent with the international literature, which has shown that structured educational programmes based on Advanced Trauma Life Support (ATLS®), Prehospital Trauma Life Support (PHTLS®), and simulation-based training are associated with improvements in theoretical knowledge, clinical decision-making, and the initial management of trauma patients. In particular, Chowdhury *et al*.,[12] reported a significant improvement in nurses' performance following intensive ATLS®-based educational programmes, whereas Dehghannezhad *et al*.[13] demonstrated sustained improvements in knowledge and clinical performance after integrated educational interventions combined with simulation-based training. Although the present study was observational and descriptive in nature, its findings are consistent with these previous reports. The absence of a clear association between years of professional experience and knowledge scores suggests that clinical experience alone may not be sufficient to maintain up-to-date knowledge of major trauma management unless supported by structured continuing education. This finding further emphasizes the importance of regular, multidisciplinary educational programmes based on realistic clinical scenarios. The use of standardized clinical scenarios in the present study allowed participants' applied knowledge to be assessed in realistic clinical situations, although it cannot replace the direct evaluation of clinical competence in everyday practice. Another relevant finding concerns the availability of structured clinical care protocols. Lower knowledge scores were observed among participants working in settings without structured protocols, whereas the difference between settings with integrated clinical care algorithms and those with only a

Table 1. Characteristics of the study population and study findings (N=170).

Section	Variable	Category	N	Value % (SD)
Participant characteristics	Age group (years)	< 30	19	11.2
		30 – 40	62	36.5
		41 – 50	54	31.7
		> 50	35	20.6
	Professional experience (years)	< 1	5	2.9
		1– 4	30	17.6
		5 –10	63	37.0
		> 10	72	42.3
	Geographical area	Northern Italy	134	78.8
		Central Italy	23	13.5
		Southern Italy	13	7.6
	Clinical setting	Prehospital	102	60.0
		Hospital	68	40.0
	Trauma training within the previous 24 months	Yes	119	70.0
		No	51	30.0
	Availability of regional clinical care algorithms	Major trauma algorithm + nursing algorithm	61	35.9
		Major trauma algorithm only	81	47.6
		No structured protocols	28	16.5
Performance in clinical scenarios	Clinical Scenario 1	-	141/170	83
	Clinical Scenario 2	-	98/170	58
	Clinical Scenario 3	-	111/170	65
	Clinical Scenario 4	-	119/170	69
	Clinical Scenario 5	-	96/170	56
	Clinical Scenario 6	-	84/170	49
Section	**Variable**	**Category**	**N**	**Value % (SD)**
Comparative analysis	Recent trauma training	Yes	119	3.61 (0.91)
		No	51	1.96 (0.77)
	Clinical care algorithms	Major trauma algorithm + nursing algorithm	61	3.30 (NA)
		Major trauma algorithm only	81	3.21 (NA)
		No structured protocols	28	2.46 (NA)

Note. Data are presented as frequencies and percentages (%) or, where appropriate, as mean (SD). SD, standard deviation; NA, not applicable.

major trauma algorithm was more modest. Given the observational design of the study, these findings do not support causal inferences regarding the effect of clinical care algorithms. Nevertheless, they suggest that shared organizational tools may facilitate nurses' clinical decision-making and contribute to greater consistency in trauma care pathways, in agreement with the current Italian recommendations for the integrated management of major trauma.[14] Several limitations should be acknowledged. First, the use of a convenience sample, the exclusive recruitment of nurses affiliated with ANIARTI, and the uneven geographical distribution of participants, with a predominance of respondents from Northern Italy, may have introduced selection bias and limit the generalizability of the findings. Second, the questionnaire was specifically developed for this study and underwent content validation only. Although the high S-CVI supports the clinical relevance of the questionnaire items, additional psychometric properties, including internal consistency and test-retest reliability, were not evaluated and should be addressed in future validation studies. Furthermore, the use of standardized clinical scenarios provides an assessment of applied knowledge but does not directly measure actual clinical performance. Finally, because of the cross-sectional observational design, no causal relationship can be established between trauma education, the availability of structured clinical care protocols, and participants' performance. Overall, the findings suggest that periodic multidisciplinary trauma education programmes, together with the implementation of shared clinical care protocols and algorithms across trauma systems, may contribute to improving the consistency of trauma care pathways and supporting nurses' clinical decision-making across emergency settings.[15,16]

Conclusions

Overall, nurses' knowledge of traumatic hypovolemic shock management was moderate. Participants who had received recent trauma education achieved higher mean knowledge scores, whereas the availability of structured clinical care protocols and algorithms was associated with better performance. However, these findings should be interpreted with caution given the observational design of the study. Because the questionnaire was specifically developed for this study and underwent content validation only, the findings should be regarded as an exploratory assessment of nurses' knowledge within the study sample rather than as a definitive measure of nurses' knowledge. Despite these methodological limitations, the findings suggest that regular multidisciplinary trauma education programmes, combined with the implementation of shared clinical care protocols and algorithms across trauma systems, may contribute to improving the consistency of trauma care pathways and supporting nurses' clinical decision-making in emergency care settings.

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Online supplementary materials

Questionnaire used in the study

Contributions: the authors contributed equally to this paper.

Conflict of interest: the authors declare that they have no conflicts of interest.

Ethical approval and informed consent: anonymous survey of healthcare professionals; no clinical patient data collected; no review by the Ethics Committee was required according to local practice.

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From classroom to emergency: knowledge acquisition and retention following nurse-led simu-lation-based BLSD education in secondary schools

Dall'aula all'emergenza: acquisizione e consolidamento delle conoscenze a seguito di un corso di formazione BLSD basato sulla simulazione e condotto da infermieri nelle scuole secondarie

Luca Dal Corso,[1] Massimiliano Aldegheri,[2] Elena Anselmi,[3] Alberto Burro,[4] Fabio Rossi,[2] Gloria Longhi,[5] Davide Silvagni,[6] Michele Zandonà,[2] Maria Angela Cerruto[7]

[1]Service for Development, Professionalism and Innovation, Integrated University Hospital of Verona; [2]Department of Emergency and Urgency, Integrated University Hospital of Verona; [3]Department of Pediatric Emergency Department, University of Verona; [4]Italian Resucitation Council Center, Integrated University Hospital of Verona; [5]Alp Trauma Clinic Dimaro; [6]Pediatric Emergency Department, Integrated University Hospital of Verona; [7]Service for Development, Professionalism and Innovation, Integrated University Hospital of Verona, Italy

ABSTRACT

Introduction: Out-of-Hospital Cardiac Arrest (OHCA) remains a major public health challenge in which early Car-diopulmonary Resuscitation (CPR) and automated external defibrillator (AED) use are critical deter-minants of survival. Despite international recommendations promoting Basic Life Support and Defib-rillation (BLSD) education in schools, first-aid training is not systematically implemented in Italian secondary education. This study evaluated the effectiveness of a nurse-led simulation-based BLSD training program in improving theoretical knowledge and medium-term retention among high school students.
Materials and Methods: a total of 430 final-year students attended an Italian Resuscitation Council (IRC)-based BLSD course including interactive lectures, realistic simulations, and structured debrief-ing. Knowledge was assessed using a standardized 20-item questionnaire administered before training (T0), immediately after training (T1), and four months later without prior notice (T2).
Results: mean correct responses increased from 42.34% at T0 to 77.02% at T1 ($p < 0.001$). At fol-low-up, scores remained significantly higher than baseline (70.44%; $p < 0.001$), despite a moderate decline compared with immediate post-training results. No gender-related differences emerged.
Conclusions: simulation-based BLSD education appears effective in promoting both knowledge ac-quisition and medium-term retention in adolescents. These findings support the potential value of nurse-led BLSD training programs in secondary schools and suggest that their integration into school curricula may represent an important educational and public health strategy.

Key words: BLSD; simulation-based education; CPR training; nurse educator; high school students; experiential learning; first responders.

RIASSUNTO

Introduzione: l'arresto cardiaco extraospedaliero (OHCA) rimane una delle principali sfide per la salute pubblica, in cui la rianimazione cardiopolmonare (RCP) precoce e l'uso del defibrillatore automatico esterno (DAE) sono fattori determinanti per la sopravvivenza. Nonostante le raccomandazioni internazionali che promuovono la formazione in materia di supporto vitale di base e defibrillazione (BLSD) nelle scuole, la formazione in primo soccorso non è sistematicamente implementata nell'istruzione seconda-ria italiana. Questo studio ha valutato l'efficacia di un programma di formazione BLSD basato sulla simulazione e condotto da infermieri nel migliorare le conoscenze teoriche e la ritenzione a medio ter-mine tra gli studenti delle scuole superiori.
Materiali e Metodi: un totale di 430 studenti dell'ultimo anno hanno frequentato un corso BLSD basa-to sulle linee guida dell'Italian Resuscitation Council (IRC), comprendente lezioni interattive, simula-zioni realistiche e debriefing strutturato. Le conoscenze sono state valutate utilizzando un questionario standardizzato di 20 domande somministrato prima della formazione (T0), immediatamente dopo la formazione (T1) e quattro mesi dopo senza preavviso (T2).
Risultati: la media delle risposte corrette è aumentata dal 42,34% al T0 al 77,02% al T1 ($p < 0,001$). Al follow-up, i punteggi sono rimasti significativamente più alti rispetto al valore basale (70,44%; $p < 0,001$), nonostante un moderato calo rispetto ai risultati immediatamente successivi alla formazione. Non sono emerse differenze legate al genere.
Conclusioni: la formazione in BLSD basata sulla simulazione sembra efficace nel promuovere sia l'acquisizione delle conoscenze sia la loro ritenzione a medio termine negli adolescenti. Questi risultati sostengono il potenziale valore dei programmi di formazione in BLSD condotti da infermieri nelle scuole secondarie e suggeriscono che la loro integrazione nei programmi scolastici possa rappresenta-re un'importante strategia educativa e di salute pubblica.

Parole chiave: BLSD; formazione basata sulla simulazione; formazione in RCP; infermiere formatore; studenti delle scuole superiori; apprendimento esperienziale; primi soccorritori.

Correspondence: Luca Dal Corso, Service for Development, Professionalism and Innovation, Integrated University Hospital of Verona, Piazzale Stefani, 1, 37126 Verona, Italy. E-mail: luca.dalcorso@aovr.veneto.it

Introduction

Out-of-Hospital Cardiac Arrest (OHCA) is a major public health problem in Europe and a leading cause of death. According to the EuReCa ONE study, the incidence of Emergency Medical Service (EMS)-treated OHCA ranges from approximately 19 to 104 cases per 100,000 inhabitants per year across participating European regions, reflecting substantial geographic variability. Survival to hospital discharge in patients receiving resuscitation attempts was approximately 10% in this study. Subsequent data from the EuReCa TWO registry confirmed persistent low survival, reporting survival to hospital discharge of about 8% across Europe. Because neurological outcome and survival are highly time-dependent, the European Resuscitation Council emphasizes the importance of rapid activation of the chain of survival, including early recognition of cardiac arrest, immediate bystander Cardiopulmonary Resuscitation (CPR), and early defibrillation, as delays in treatment are strongly associated with reduced survival and worse neurological outcome.[1-3]

For this reason, international organizations such as the European Resuscitation Council (ERC) and the World Health Organization advocate the widespread dissemination of Basic Life Support and Defibrillation (BLSD) competencies among laypersons, particularly adolescents. The ERC Guidelines 2021 on Education for Resuscitation specifically recommend the implementation of CPR training in schools and support the "Kids Save Lives" initiative, which promotes the systematic teaching of resuscitation skills to school-aged children and adolescents. Schools represent an ideal setting for emergency education because students are highly receptive to active learning approaches and may act as multipliers of health knowledge within their families and communities.

Despite these recommendations, BLSD education is not systematically integrated into Italian secondary school curricula. Consequently, many students reach adulthood without adequate preparation to recognize and respond to cardiac arrest situations.

Simulation-based education has increasingly emerged as an effective strategy for emergency training. According to experiential learning theory, active participation and reflection on experience facilitate knowledge acquisition and retention.[4,5] In healthcare education, simulation provides opportunities to apply theoretical knowledge in realistic and controlled environments, supporting the development of practical skills, clinical reasoning, and decision-making abilities.[6,7]

Furthermore, simulation-based training has been associated with improved cognitive, psychomotor, and affective learning outcomes and has demonstrated greater educational effectiveness compared with traditional teaching approaches across a variety of healthcare education settings.[8]

Debriefing is widely recognized as a core element of simulation-based education, facilitating guided reflection, feedback, critical analysis of actions, and the integration of new knowledge into future practice.[9,10] Within this educational framework, nurse instructors play an important role in planning, facilitating, and evaluating simulation activities, contributing to the effectiveness of the learning process.[11]

The present study aimed to evaluate the effectiveness of a nurse-led simulation-based BLSD course in improving theoretical knowledge and medium-term knowledge retention among high school students. These outcomes were assessed using a standardized 20-item questionnaire administered at baseline, immediately after training, and four months following course completion.

Materials and Methods

A longitudinal observational study was conducted involving 430 final-year secondary school students. Participants were recruited from five different educational pathways, including a scientific high school (n = 86), a classical high school (n = 86), a technical institute (n = 86), a vocational institute (n = 86), and a humanities high school (n = 86). This distribution was intended to provide a heterogeneous sample representative of different secondary educational backgrounds.

No student had previously participated in CPR teaching activities at school.

All participants were legally adults at the time of enrollment. The sample included 232 female students (53.95%) and 198 male students (46.05%).

This study was an anonymous, non-interventional educational research project conducted in secondary schools and involving competent adult participants. The study did not include any clinical interventions, collection of biological samples, or processing of sensitive health-related data. In accordance with the applicable Italian regulations governing non-interventional educational research, formal approval by an Ethics Committee was not required.

The project was approved by the governing bodies of the participating schools, including the School Council and the Class Councils, in accordance with institutional procedures. Prior to participation, all students, who were 18 years of age or older, received detailed information about the study and provided written informed consent. Participation was entirely voluntary, all questionnaires were completed anonymously, and participants were informed of their right to decline participation or withdraw at any time without any academic or personal consequences.

The BLSD training program was developed according to Italian Resuscitation Council (IRC) guidelines and delivered by IRC-certified instructors with professional experience in emergency and critical care settings. The educational team included 33 nurses specifically trained in simulation-based education.

Participants were recruited from five secondary schools located in the same geographic area. Schools were selected through a convenience sampling strategy based on institutional availability and prior educational collaborations. Participation was approved at the institutional level by the school leadership, the teachers' councils, and the school boards of the participating institutions, which agreed to take part in the study.

A total of 430 final-year students participated, with 86 students enrolled from each school. All participants were adults (≥18 years old) and provided written informed consent prior to participation. All eligible students within the selected classes were invited to participate. The final sample therefore represents students who attended the scheduled training sessions and provided complete data at all assessment time points.

The course was structured into three sequential phases: pre-course assessment, interactive theoretical session, and simulation-based practical training.

Pre-course assessment

Before training, participants completed a 20-item multiple-choice questionnaire assessing theoretical knowledge of cardiac arrest recognition, Cardiopulmonary Resuscitation (CPR), Automated External Defibrillator (AED) use, emergency system activation, and foreign body airway obstruction management.

The questionnaire was developed by the research team through a structured expert-based process involving clinicians and instructors with experience in emergency care and BLSD training. Items were generated based on the IRC-BLSD curriculum and the

learning objectives of the training program. The draft instrument underwent expert review to assess content relevance, clarity, and appropriateness for adolescent learners, leading to minor revisions to improve comprehensibility.

The questionnaire was not subjected to formal psychometric validation; however, content validity was ensured through expert consensus and alignment with IRC guidelines. The full instrument is provided in the Supplementary Material.

The same questionnaire was administered at all three time points to allow longitudinal comparison of knowledge acquisition and retention.

Interactive theoretical session

Students attended a 45-minute lesson covering OHCA recognition, activation of emergency medical services, CPR sequences, AED use, and airway obstruction management. The session was delivered using interactive teaching methods, including guided discussion, real-life examples, and question-and-answer activities. Educational content was adapted to adolescent learners through age-appropriate language and contextualized emergency scenarios.

Simulation-based practical training

Participants subsequently attended 3.5 hours of practical simulation training in small groups with a student-to-instructor ratio of 6:1.

Simulation sessions were conducted using adult mannequins and AED trainers in realistic scenarios reproducing familiar school environments, including classrooms, corridors, and sports facilities. Students practiced chest compressions, AED application, and foreign body airway obstruction maneuvers under instructor supervision.

The simulation design followed established principles of simulation-based education, emphasizing deliberate practice, contextual realism, active learner engagement, and structured facilitation to support meaningful learning experiences.[7,9,11]

Each session concluded with a structured debriefing phase aimed at supporting reflective learning and knowledge consolidation. Debriefing was conducted according to contemporary simulation-based education frameworks, which identify guided reflection, feedback, learner-centered discussion, and psychological safety as key components of effective learning following simulation experiences.[9,10]

Post- course assessment and four- month follow- up

Immediately after course completion, all participants completed the same questionnaire administered at baseline (T1).

A follow-up assessment was conducted four months later (T2). The four-month interval was primarily selected for practical and organizational reasons, as extending the follow-up beyond the end of the academic year could have increased the risk of participant attrition due to school transfers, relocation, or other factors affecting student availability. This timeframe also allowed the evaluation of medium-term knowledge retention while maintaining a high follow-up rate. Students were not informed in advance of the reassessment in order to reduce preparation bias and better evaluate spontaneous knowledge retention over time. All 430 participants completed all three assessment time points (T0, T1, and T2), with no loss to follow-up or missing data.

Data analysis

The collected data were analyzed using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) for data entry, data cleaning, and descriptive statistics. For each assessment phase (pre-course, T0; post-course, T1; and four-month follow-up, T2), the percentage of correct responses was calculated for each participant. Descriptive statistics were used to summarize demographic characteristics and performance trends across the three assessment points.

Inferential statistical analyses were performed using JASP (JASP Team, University of Amsterdam, The Netherlands, version 0.17.2). Given the repeated-measures design and the non-normal distribution of the outcome variable, changes in knowledge scores over time were analyzed using the Wilcoxon signed-rank test for paired samples. Pairwise comparisons were conducted between T0 and T1 to evaluate immediate knowledge acquisition, between T1 and T2 to assess medium-term retention, and between T0 and T2 to evaluate overall knowledge retention at four months after course completion. Statistical significance was set at $p<0.05$.

Results

The results are graphically illustrated in Figure 1. All 430 enrolled students completed the assessments at baseline (T0), immediately after training (T1), and at the four-month follow-up (T2), resulting in a 100% follow-up rate. Baseline assessment demonstrated limited theoretical knowledge regarding BLSD and OHCA management. The mean percentage of correct responses before training (T0) was 42.34% (±7.2). Immediately after course completion (T1), mean scores increased significantly to 77.02% (±6.5), corresponding to an improvement of 34.68 percentage points compared with baseline ($p<0.001$). At four-month follow-up (T2), participants maintained significantly higher scores than baseline, with a mean percentage of correct responses of 70.44% (±7.1) ($p<0.001$ *vs* T0). Although a moderate reduction compared with immediate post-course performance was observed (−6.58 percentage points), knowledge retention remained substantial.

No statistically significant differences were identified between male and female students across any assessment phase.

Discussion

The present study demonstrates that simulation-based BLSD education significantly improves theoretical knowledge among high school students and supports medium-term retention of learning outcomes.

The substantial increase in post-training scores observed in this

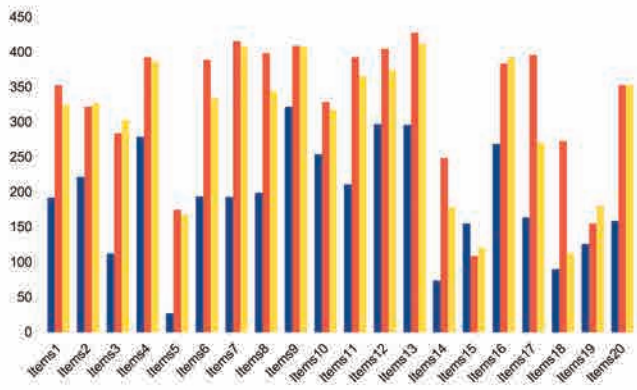


Figure 1. Analysis of BLSD knowledge assessment scores across three time points (T0, T1, T2).

study is consistent with previous research on school-based CPR and BLSD training, which has shown that active and simulation-based learning approaches are effective in improving knowledge acquisition among adolescents.[12-14] In line with the existing literature, our findings also indicate a partial decline in knowledge at follow-up compared with immediate post-training assessment; however, performance at four months remained substantially higher than baseline levels, supporting the presence of sustained medium-term retention after initial training.

These results are aligned with international recommendations from the European Resuscitation Council and the World Health Organization, which advocate for the implementation of CPR training within school curricula.[15,16] Despite these recommendations, implementation remains heterogeneous across countries and is not yet systematically integrated into secondary education in several settings, including Italy.

The intervention was based on simulation scenarios delivered in a school environment. Although this study did not assess psychosocial or affective outcomes, previous literature suggests that simulation-based education may facilitate active learning and contextual understanding in CPR training contexts.[16,17] In the present study, outcomes were limited to theoretical knowledge acquisition and retention; therefore, interpretations regarding motivational or emotional dimensions cannot be derived from the available data.

Finally, the involvement of nurse instructors ensured structured delivery of the educational intervention. While the specific pedagogical contribution of nurse-led instruction was not separately evaluated, the overall results support the effectiveness of nurse-led simulation-based BLSD training in improving and maintaining knowledge over time. Future studies should further investigate the role of instructional factors as well as potential effects on behavioral and psychosocial outcomes in school-based resuscitation education.

An additional aspect of the intervention concerns the role of the nurse instructor. In this study, nurse-led simulation-based training was associated with significant improvements in knowledge acquisition and retention among high school students; however, psychosocial outcomes such as motivation, emotional engagement, and perceptions of psychological safety were not assessed.

Within the existing educational literature, instructor facilitation in simulation-based learning is considered to support active learning through structured feedback, communication, and debriefing. In this context, the role of nurse instructors may extend beyond technical instruction to the facilitation of experiential learning processes, although this interpretation cannot be inferred from the present data.

These considerations are consistent with theoretical frameworks in simulation-based education, but they should be regarded as hypotheses requiring empirical verification in future studies rather than as findings of the present work.

The four-month follow-up demonstrated a moderate decline in scores compared with immediate post-course assessment, consistent with the natural decay of theoretical knowledge over time reported in previous studies.[18] Nevertheless, retention levels remained significantly higher than baseline, suggesting durable educational benefits. The effectiveness of such reinforcement strategies has been well-documented, particularly in educational models that include spaced repetition and blended learning.[19]

These findings support the integration of periodic refresher sessions and repeated simulation exposure to reinforce long-term retention. Educational models based on spaced repetition and recurrent simulation may further strengthen both cognitive and psychomotor competencies.

Importantly, the study also confirms that there were no statistically significant gender differences in performance across all time points, aligning with previous literature that suggests both male and female students benefit equally from structured CPR training.[20]

The study has several limitations. First, only theoretical knowledge was evaluated, while practical skills performance was not objectively assessed. Second, the absence of a control group limits direct comparison with traditional lecture-based education. The study evaluated medium-term retention only, without long-term follow-up beyond four months.

Another limitation of this study is that the questionnaire, although developed through a structured expert-based process and reviewed for content validity, was not formally psychometrically validated. Therefore, its measurement properties, including construct validity and reliability, were not formally established. While the questionnaire was specifically designed to assess the educational objectives of the IRC-BLSD training programme, the lack of formal validation may have affected the precision of the measurements and limits the external validity and generalizability of the findings.

Although inferential analyses were performed using appropriate non-parametric tests, effect size estimates were not available. The absence of effect size measures limits the interpretation of the magnitude of the observed changes in knowledge scores beyond statistical significance.

The present study focused primarily on learning outcomes in terms of theoretical knowledge acquisition and retention. While the educational intervention incorporated interactive and learner-centered instructional strategies, no formal evaluation of participants' engagement, satisfaction, perceived relevance, or educational experience was conducted. Therefore, no conclusions can be drawn regarding these process-related dimensions.

Future research should integrate both outcome and process measures to provide a more comprehensive evaluation of school-based CPR education programs. In addition, future studies should include formal psychometric evaluation of the assessment instrument in larger and more diverse populations, as well as prospective reporting of effect sizes with confidence intervals to better quantify the educational impact of CPR training programs.

Despite these limitations, the study demonstrates significant improvements in theoretical knowledge following nurse-led simulation-based BLSD training, with sustained retention at four months.

Conclusions

Nurse-led simulation-based BLSD education significantly improved theoretical knowledge and supported medium-term knowledge retention among high school students. These findings suggest that simulation-based educational approaches may be effective for teaching basic life support concepts in secondary school settings. Integrating BLSD training into school curricula could represent a valuable strategy for improving community preparedness for cardiac arrest emergencies. Further research is needed to investigate the effects of such programs on behavioral, motivational, and psychosocial outcomes.

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Informed consent: written informed consent was obtained from all participants prior to participation. Participation was voluntary, and participants were informed of their right to decline participation or withdraw from the study at any time without any academic or personal consequences.y.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

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Knowledge and perceptions of donation after circulatory death among nurses: a multicentre survey in Northern Italy

Conoscenze e percezioni relative alla donazione dopo arresto cardiocircolatorio tra il personale infermieristico: un'indagine multicentrica nel Nord Italia

Lorenzo Righi,[1,2,3] Vittorio Uggè,[4] Alessio Caratelli,[5] Giulia Martinenghi,[6] Moris Rosati,[7] Christian Ramacciani Isemann[8]

[1]Responsible Nurse for Monitoring Nursing Outcomes, USL Toscana Sud Est, Siena; [2]Vice President, OPI Siena, Siena; [3]Adjunct Lecturer, University of Siena, Siena; [4]Operating Room Nurse, A.S.S.T. of Crema – Ospedale Maggiore, A.T.S. Val Padana; [5]Nurse, Cardiac Surgery Unit, Azienda Ospedaliero-Universitaria Senese (AOUS), Siena; [6]Nurse, Coronary Care Unit (CCU), I.R.C.C.S. Centro Cardiologico Monzino, Milan; [7]Nurse Coordinator, Cardiology and Cardiac Intensive Care Unit, Azienda Ospedaliera Universitaria Senese (AOU), Siena; [8]Nurse Coordinator, Operating Theatre, Val di Chiana United Hospitals, USL Toscana Sud Est Health Authority, Italy

ABSTRACT

Introduction: donation after Circulatory Death (DCD) has become an increasingly important strategy for expanding the donor pool and addressing the persistent shortage of organs available for transplantation. Nurses play a key role throughout the donation process; however, evidence regarding their knowledge of DCD in Italian healthcare settings remains limited.
Materials and Methods: a multicentre cross-sectional survey was conducted between June and July 2024 among registered nurses working in three hospitals in Northern Italy. An adapted version of a previously published questionnaire was used to assess knowledge and perceptions regarding DCD. Data were analysed using descriptive statistics.
Results: a total of 113 nurses participated in the study. Nearly two-thirds (64.6%) reported previous exposure to organ or tissue donation pathways, whereas only 20.4% had received specific education on DCD. Most participants recognised that tissue donation (92.0%) and solid organ donation (79.6%) may be possible following circulatory arrest. However, important knowledge gaps emerged regarding death determination criteria (41.6%), donor classification systems (16.8%), and the implications of the no-touch period (17.7%).
Conclusions: nurses demonstrated general awareness of DCD but limited knowledge in several procedure-specific areas. Structured educational initiatives addressing both technical and ethical aspects of DCD may improve preparedness and support the implementation of DCD programmes in clinical practice.

Key words: tissue and organ procurement, organ donation, transplantation, nurses, knowledge, education, nursing.

RIASSUNTO

Introduzione: la donazione dopo morte circolatoria (Donation after Circulatory Death, DCD) è diventata una strategia sempre più importante per ampliare il bacino dei donatori e far fronte alla persistente carenza di organi disponibili per il trapianto. Gli infermieri svolgono un ruolo fondamentale durante l'intero processo di donazione; tuttavia, le evidenze relative alle loro conoscenze in materia di DCD nelle strutture sanitarie italiane rimangono limitate.
Materiali e Metodi: tra giugno e luglio 2024 è stata condotta un'indagine trasversale multicentrica tra infermieri abilitati che lavorano in tre ospedali del Nord Italia. È stata utilizzata una versione adattata di un questionario precedentemente pubblicato per valutare le conoscenze e le percezioni relative alla DCD. I dati sono stati analizzati utilizzando statistiche descrittive.
Risultati: allo studio hanno partecipato in totale 113 infermieri. Quasi due terzi (64,6%) hanno riferito di aver già avuto a che fare con i percorsi di donazione di organi o tessuti, mentre solo il 20,4% aveva ricevuto una formazione specifica sulla DCD. La maggior parte dei partecipanti ha riconosciuto che la donazione di tessuti (92,0%) e quella di organi solidi (79,6%) possono essere possibili in seguito a un arresto circolatorio. Tuttavia, sono emerse importanti lacune conoscitive riguardo ai criteri di accertamento del decesso (41,6%), ai sistemi di classificazione dei donatori (16,8%) e alle implicazioni del periodo di non intervento (17,7%).
Conclusioni: gli infermieri hanno dimostrato una consapevolezza generale della DCD, ma una conoscenza limitata in diverse aree specifiche relative alle procedure. Iniziative formative strutturate che affrontino sia gli aspetti tecnici che quelli etici della DCD potrebbero migliorare la preparazione e sostenere l'attuazione dei programmi di DCD nella pratica clinica.

Parole chiave: prelievo di tessuti e organi, donazione di organi, trapianto, infermieri, conoscenza, formazione, assistenza infermieristica.

Correspondence: Lorenzo Righi, affiliazione preferita con indirizzo postale completo.
E-mail: lorenzo.righi@unisi.it

Introduction

Donation after Circulatory Death (DCD) has become an increasingly important strategy for expanding the pool of organs available for transplantation and addressing the persistent shortage of donors worldwide.[1,2] In Italy, the progressive implementation of DCD programmes has introduced new clinical, organisational, and ethical challenges, requiring healthcare professionals to develop specific competencies related to donor identification, end-of-life care, death determination, and donation pathways.[2,3]

Nurses play a pivotal role throughout the DCD process. Their responsibilities include the clinical management of potential donors, collaboration with multidisciplinary teams, communication with families, and support of donation procedures.[3,4] Consequently, adequate knowledge and understanding of DCD principles are essential to ensure the quality, safety, and ethical integrity of the donation process.

Previous studies have reported variability in healthcare professionals' knowledge and preparedness regarding organ donation and DCD, highlighting the need for targeted educational initiatives and continuing professional development.[4-9] Recent evidence from Sweden has further shown that intensive care nurses frequently report limited knowledge of DCD and identify educational and ethical support needs during the implementation of DCD programmes.[10,11] Despite the growing adoption of DCD pathways across Europe, evidence describing nurses' knowledge of DCD in Italian hospital settings remains limited.

Therefore, this cross-sectional survey aimed to describe nurses' knowledge and perceptions regarding donation after circulatory death in three Italian hospitals and to identify potential areas for educational improvement to support the implementation of DCD programmes.

Materials and Methods

Study design

A cross-sectional observational study was conducted between June and July 2024 as part of an undergraduate Nursing Degree thesis at the University of Milan. The study involved registered nurses working in three hospitals in the Lombardy Region, Italy: ASST Crema – Ospedale Maggiore, ASST Bergamo Ovest – Ospedale di Treviglio-Caravaggio, and IRCCS Centro Cardiologico Monzino. Nurses working in mental health, maternal–child health, and home care services were excluded to ensure consistency with the study objectives, which focused on hospital settings potentially involved in organ donation pathways.

Participants

Registered nurses employed in the participating hospital wards were invited to participate voluntarily and anonymously. No personally identifiable information was collected. Before accessing the questionnaire, participants received information regarding the study aims and provided electronic informed consent.

Survey instrument

Data were collected using a questionnaire adapted, with permission from the original authors, from the instrument developed by Caratelli *et al*.[9] The original questionnaire, described by its authors as a non-standardized instrument, was designed to investigate nurses' knowledge, experiences, and perceptions regarding organ and tissue donation, with particular focus on DCD. The original questionnaire had not undergone formal psychometric testing or validation.

The adapted questionnaire retained the original structure and consisted of 19 multiple-choice items organized into two sections. The first section (items 1–8) collected socio-demographic and professional characteristics, whereas the second section (items 9–19) explored participants' knowledge and perceptions regarding organ donation and DCD.

Only minor modifications were introduced to improve terminology and adapt the questionnaire to the local context without altering the constructs investigated. Specifically, the term Non-Heart-Beating Donor (NHBD) was replaced with the currently adopted terminology DCD; one item was replaced with an open-ended question aimed at collecting descriptive information regarding previous DCD-related educational activities; and the socio-demographic section was adapted to the characteristics of the study population.

Before dissemination, the adapted questionnaire underwent a preliminary face-validity assessment in a small group of registered nurses to evaluate clarity and comprehensibility. Feedback resulted only in minor wording refinements before the final version was distributed. Since the modifications did not alter the conceptual framework of the original instrument, no additional psychometric validation or reliability testing was performed.

Data collection

The questionnaire was administered through Google Forms using a web link and QR code distributed within the participating hospitals. The introductory page explained the study objectives, guaranteed anonymity, and included the informed consent statement. Before data collection, authorization to conduct the study and distribute the questionnaire was obtained from the management of the participating healthcare institutions.

Statistical analysis

Data were exported to Microsoft Excel and analysed using IBM SPSS Statistics. Categorical variables were summarized as absolute frequencies and percentages. The questionnaire did not generate an overall knowledge score. Each item was analysed individually, and responses were summarized using frequencies and percentages. Comparisons between the Lombardy sample and the national study by Caratelli *et al.*[7] were performed using Pearson's chi-square test for comparable questionnaire items, with statistical significance set at $p < 0.05$.

Considering the substantial differences in sample size, geographical distribution, and organizational context between the two study populations, comparative analyses were interpreted as exploratory and descriptive rather than intended to support population-level inference.

Ethical considerations

The study consisted of an anonymous, voluntary questionnaire survey and did not involve the collection of personally identifiable or sensitive data. According to applicable national regulations and institutional procedures, formal Ethics Committee approval was not required for this type of study. Participation was voluntary, and electronic informed consent was obtained from all participants before completion of the questionnaire.

Results

A total of 113 nurses participated in the survey. Nearly two-

thirds of respondents (64.6%) reported previous exposure to organ or tissue donation pathways during their professional activity, whereas only 20.4% had received specific education on DCD (Table 1).

Participants' perceptions regarding DCD were generally favourable. Most respondents recognised that tissue donation (92.0%) and solid organ donation (79.6%) may be possible following circulatory arrest. In addition, 87.6% were aware that donation pathways can be activated after cardiac arrest under specific circumstances. These findings suggest a generally positive perception of the feasibility of DCD among participating nurses.

Despite this general awareness, relevant knowledge gaps emerged in several DCD-specific domains. Only 41.6% correctly identified the circulatory criteria used for death determination, 16.8% correctly recognised donor classification systems, and 17.7% correctly understood the implications of the no-touch period. Knowledge of DCD operational procedures was reported by 71.7% of respondents.

Overall, the findings suggest that nurses were generally familiar with the concept and potential of DCD and expressed favourable perceptions towards donation after circulatory death. However, important deficiencies remained regarding specific procedural, regulatory, and clinical aspects of the donation pathway (Table 1).

Discussion

This study explored nurses' knowledge and perceptions regarding donation after circulatory death (DCD) in three hospitals in the Lombardy Region and compared the findings, from an exploratory perspective, with those reported by Caratelli *et al.*[7] Although the two studies differed substantially in sample size, geographical distribution, and organizational context, the comparison provides useful insights into areas of consistency and variability that may help identify educational priorities and organizational needs.

Overall, the findings indicate that nurses demonstrated an adequate understanding of general concepts related to organ donation, whereas greater uncertainty emerged regarding DCD-specific issues, particularly the cardiocirculatory criteria for death determination, donor eligibility following cardiac arrest, and the clinical implications of the no-touch period. These findings are consistent with previous studies reporting that healthcare professionals generally possess satisfactory knowledge of organ donation but continue to show important gaps in the organizational, ethical, and clinical aspects specific to DCD.[3,10,11] Recent qualitative evidence has further shown that nurses involved in DCD identify educational needs, ethical challenges, and communication with families as key issues requiring structured institutional support, reinforcing the importance of comprehensive educational programmes for professionals involved in donation pathways.[12]

Direct experience with organ donation during routine clinical practice was more frequently reported in the Lombardy sample than in the national cohort described by Caratelli *et al.*[7] However, greater clinical exposure did not consistently correspond to higher levels of theoretical knowledge across all DCD-related domains. This finding suggests that practical experience alone may be insufficient to ensure an adequate understanding of the principles underlying DCD and highlights the importance of integrating structured educational initiatives with clinical experience.

The differences observed between the two study populations should be interpreted cautiously. They may reflect differences in organizational context, educational opportunities, and exposure to donation pathways rather than true differences in professional competence. Because the present study was not designed to investigate these factors directly, no causal relationship can be established. Nevertheless, these contextual factors should be considered when interpreting the findings and may partly explain the variability observed across different healthcare settings. Furthermore, the participating hospitals had different levels of experience with organ donation pathways, which may also have influenced nurses' baseline knowledge and familiarity with DCD-related procedures.

From an educational perspective, the results support the implementation of structured training programmes specifically focused on DCD. Educational interventions should extend beyond traditional lectures and include simulation-based training, multidisciplinary educational activities, clinical audit, and regular refresher courses to improve both theoretical knowledge and preparedness for clinical practice. These findings are consistent with previous evidence suggesting that educational programmes should encompass not only technical competencies but also ethical decision-making and communication with families involved in the donation process.[6,11,12] Strengthening educational pathways may contribute to greater consistency in DCD management, improve nurses' confidence when participating in donation pathways, and facilitate the implementation of DCD programmes across different healthcare settings.

Table 1. Professional characteristics, knowledge and perceptions regarding Donation after Circulatory Death (DCD) among nurses (N=113).

Variable	n (%)
Professional characteristics	
Previous exposure to organ/tissue donation pathways	73 (64.6)
Previous DCD training	23 (20.4)
Perceptions regarding DCD	
Perception that organ donation may be possible after circulatory arrest	99 (87.6)
Perception that tissue donation may be possible after circulatory arrest	104 (92.0)
Perception that solid organ donation may be possible after circulatory arrest	90 (79.6)
Knowledge regarding DCD	
Correct identification of circulatory criteria for death determination	47 (41.6)
Correct understanding of donor classification systems	19 (16.8)
Correct understanding of the impact of the no-touch period	20 (17.7)
Knowledge of DCD operational procedures	81 (71.7)

DCD, Donation after Circulatory Death. Percentages are calculated on the total sample (N = 113).

The findings also highlight the need for greater standardization of educational content concerning DCD, particularly regarding the criteria for death determination, donor selection, classification systems, and operational procedures. Addressing these knowledge gaps may improve nurses' confidence, promote more consistent clinical decision-making, and ultimately support the quality, safety, and ethical integrity of the donation process.

Limitations

This study has several limitations. First, the comparison with the national study by Caratelli *et al.*[7] was exploratory and involved two studies conducted in different periods and organizational settings, with substantially different sample sizes. Therefore, the findings cannot be generalized to the wider nursing population, nor can causal relationships be inferred. Second, the questionnaire was adapted from a previously published non-standardized instrument. Although only minor modifications were introduced and face validity was assessed before administration, the exact number of nurses involved in the preliminary face validity assessment was not recorded. Furthermore, no formal psychometric validation or reliability testing was performed in the present study. Third, participation was voluntary and anonymous, which may have introduced selection bias, as nurses with greater interest in or previous exposure to organ donation pathways may have been more likely to participate. Finally, the study was conducted in three hospitals within a single Italian region, limiting the transferability of the findings to other healthcare settings.

Despite these limitations, this study provides valuable preliminary evidence on nurses' knowledge and perceptions regarding DCD within Italian hospital settings. The findings identify specific educational gaps that may inform the development of targeted training programmes and support future multicentre studies aimed at strengthening nurses' preparedness for donation after circulatory death.

Conclusions

The present study identified both strengths and educational needs in nurses' preparedness regarding donation after circulatory death. Although participants demonstrated satisfactory knowledge of general organ donation principles, important uncertainties remained regarding DCD-specific clinical, organizational, and ethical aspects. These findings support the development of structured and standardized educational programmes aimed at strengthening nurses' competence and confidence in managing DCD pathways. Future multicentre studies involving larger and more heterogeneous populations are warranted to evaluate the impact of educational interventions and organizational factors on nurses' preparedness for donation after circulatory death.

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Contributions: Lorenzo Righi, conceptualization, including formulation of the research objectives and coordination of the research team; writing – review & editing, including critical revision of the manuscript and methodological supervision; Vittorio Uggè, data curation, including data management, dataset organization, and support for statistical analysis; writing – original draft, including preparation of the first manuscript draft and results sections; Alessio Caratelli, methodology, including study design and adaptation of the survey instrument; writing – review & editing, including contributions to the methodological sections and overall manuscript coherence; Giulia Martinenghi, investigation, including data collection across participating centres and contribution to the development of table and the materials and methods section; Christian Ramacciani Isemann, supervision, including overall study coordination and validation of scientific content; writing – review & editing, including critical manuscript revision and quality assurance of the study. All authors read and approved the final version of the manuscript.

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Ethical principles: the study was conducted in full accordance with the ethical principles outlined in the Declaration of Helsinki of 1964 and its subsequent amendments, including the 2013 revision. Participation was voluntary and anonymous. Completion of the questionnaire was considered as implied informed consent. Respondent anonymity and data confidentiality were fully ensured throughout the study.

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