The Use of Simulation in EMS Education & Training

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Objectives

- Describe a functional definition of simulation
  - Be familiar with a brief history of simulation in medical education
- Discuss benefits of simulation and rationale for use
- Describe a few areas of simulation in EMS education

Simulation Defined

Simulation (SIM) encompasses any technology or process that re-creates a contextual background that allows a learner to *make decisions,* experience success, mistakes, receive feedback, and gain confidence in a *learner-oriented environment that is void of patient risk.*[1]

1. Gaba DM. The future vision of simulation in healthcare. Qual Saf Health Care 2004;13(Suppl):i2-10.

Clinical Simulation - Laerdal

- Modern era of simulation has its origins in late 20th century
- Asmund Laerdal – Norwegian publisher and toy manufacturer
- Resusci-Anne® (1960s)

Clinical Simulation - Laerdal

- Encouraged by Norwegian anesthesiologist Dr. Bjorn Lind following Dr. Safar's work on mouth-to-mouth resuscitation[2,3]
- Based on evidence of efficacy of closed chest massage, Dr. Safar convinced Laerdal to include an internal spring attached to chest wall to simulate compressions[4,5]
- Possibility for training for ABCs on a simulator was born[6]

2. Safar P, Escarraga L, Elam J. A comparison of the mouth-to-mouth and mouth-to-airway methods of artificial respiration with chest-pressure arm-lift methods. N Engl J Med 1958;258:671-7.
3. Safar P. Ventilatory efficacy of mouth-to-mouth artificial respiration. Airway obstruction during manual and mouth-to-mouth artificial respiration. JAMA 1958;167:335-41.
4. Kouwenhoven WB, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. JAMA 1960;173:1064-7.
5. Jude JR, Kouwenhoven WB, Knickerbocker GG. Cardiac arrest: report of application of external cardiac massage on 118 patients. JAMA 1961:178:163-71
6. Safar P, Brown TC, Holtey WH, Wilder RJ. Ventilation and circulation with closed chest cardiac massage in a man. JAMA 1961:176:574-6.

Clinical Simulation – Sim One

- Starting point (mid 1960's) for true computer controlled, mannequin simulators of entire patient[8-10]
- Dr. Stephenson Abrahamson (engineer)
- Dr. Judson Denson (physician)
- USC
- Collab w/ Sierra Engineering and Aerojet General Corporation

8. Denson J, Abrahamson S. A computer-controlled patient simulator. JAMA 1969;208:504-8.
9. Carter D. Man-made man: anaesthesiological medical human simulator. J Assoc Adv Med Instrum 1969;3:80-6.
10. Abrahamson S, Denson J, Wolf R. Effectiveness of a simulator in training in anesthesiology. In Ray CD. Medical Engineering. Chicago: Yearbook, 1974:370-4.

Clinical Simulation – Sim One

- Supported by 3-year $270,000 grant from US Office of Edu
  - 4,096 words
  - Blinking eyes
  - Pupils change size
  - Jaw opening
  - Breathes
  - Heart beat
  - BP
  - Pulses
  - Drug response
  - Basic airway

Clinical Simulation – Sim One

- Failed to achieve acceptance
- Only 1 constructed
- Too expensive
- Apprenticeship model

- Too ahead of their time

Clinical Simulation - Harvey

- Full sized mannequin simulating 27 cardiac conditions
- Earliest example of modern concept of part-task trainer
- First demonstrated (1968) at AHA Scientific Sessions by Dr. Michael Gordon (U of Miami Medical School)[11-12]

11. Gordon MS. Cardiology patient simulator: development of an automated manikin to teach cardiovascular disease. Am J Cardiol 1974;34:350-5.
12. Gordon MS, Ewy GA, Felner JM, et al. Teaching bedside cardiologic examination skills using "Harvey," the cardiology patient simulator. Med Clin North AM 1980;64:305-13.

Clinical Simulation - Harvey

- Displays
  - BP by auscultation
  - Bilateral JVP
  - Arterial pulses
  - Precordial impulses
  - Heart sounds in 4 classic areas
  - Breathing

- Studies showed enhanced confidence and ability to interpret cardiac findings on patients[13,14]
- Used to teach medical students, residents, physicians

13. Ewy G, Felner J, Juul D, et al. Test of a cardiology patient simulator with students in fourth-year electives. J Med Educ 1987;62:738-43.
14. JO, Calhoun JG, Tenhaken JD, et al. Harvey: the impact of a cardiovascular teaching simulator on student skill acquisition. Med Teach 1987;9:53-7.

Clinical Simulation - SP

- Standardized patients (SP)
- Patient actors to educate began in 1963[15]
  - USC neurology 3rd year clerkship
- Gynecology – teaching nl pelvic exam (1968)[16]
- AAMC survey showed >3/4 schools using SPs (1993)
- First required SP exam for US med students – Step II Clinical Skills – held in 2004 as part of licensing process

15. Rosen K. The history of medical simulation. 2008 J Crit Care 23:157-166.
16. Kretzschmar RM. Evolution of the gynecology teaching associate: an education specialist. Am J Obstet Gynecol 1978;132:64-7.

Clinical Simulation - HFS

- High-Fidelity Simulator/Simulation (HFS)
- 1980's high-fidelity simulator production resurrected
- Independently, two simulators developed
  - ~same time
  - Opposite ends of the US
- Stanford
- University of Florida

Clinical Simulation - HFS

- Stanford Med School affiliated VA Palo Alto Health Care System: David Gaba et al.
- Developed simulator for investigating human performance in anesthesia (and safety)
- CASE (Comprehensive Anesthesia Simulation Environment)
  - Mannequin placed in real OR w/ real equipment
  - Beginning of high realism
  - ACRM (Anesthesia Crisis Resource Management)
- CASE system/software licensed and - sold to Medsim Ltd.

CASE 0.5 (June 1986). Proto-prototype of the modern anesthesia patient simulator. Note minimal mannequin (center right) and minimal audiovisual system (lower left).

Clinical Simulation - HFS

Univ of Florida – Gainesville Anesthesia Simulator (GAS)

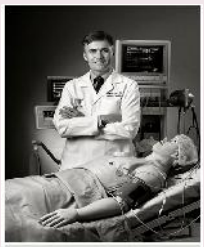
Developed by Dr. Michael Good & Dr. JS Gravenstein[17]

Utilized to train anesthesia residents basic clinical skills

In contrast to CASE, software enables physiological changes both predefined and in response to actions of trainer/trainee

Licensed & ultimately controlled by METI Inc.

17. Good M, Lampopang S, Gibby G, Gravenstein J: Critical events simulation for training in anesthesiology. J Clin Monit and Computing 1988: 4:140



2000's

SimMan

Spread of Simulation[18-19]

- Anesthesiology
- Internal medicine
- Pediatrics/neonatology
- Cardiology
- Radiology
- Trauma/Armed forces
- Nursing
- Emergency Medical Services/Disaster Medicine
- Emergency Medicine

18. McCoy C, Menchine M, Anderson C, Kollen R, Langdorf M, Lotfipour S. Prospective randomized crossover study of simulation vs. didactics for teaching medical students the assessment and management of critically ill patients. J Emerg Med 2011 Apr;40(4):448-55.
19. Rosen K. The history of medical simulation. J Crit Care. 2008 Jun;23(2):157-66.

Why use simulation?

- Provides a safe, supportive educational environment[20]
- Allows learner to practice/develop skills w/o patient risk
- Encourages skill acquisition through experience[21]
- Allows and stimulates reflection on performance[22]

20. Gordon J, Wilkerson W, Shaffer D, Armstrong E. 'Practising' medicine without risk: students' and educators' responses to high-fidelity patient simulation. Acad Med 2001;76:469-72.
21. Kolb D. Experiential Learning: Experience as a Source of Learning and Development. Englewood Cliffs, NJ: Prentice Hall PTR 1984.
22. Schon D. Educating the Reflective Practitioner. San Francisco: Jossey-Bass Publishers 1987.

Why use simulation?

- Tasks/scenarios can be created to demand[23]
- Skills can be practiced repeatedly[23]
- Training can be tailored to the individual[23]
- Retention and accuracy are increased[23]
- Transfer from classroom to real situation is enhanced[23]
- Allows for the standardization of evaluation[23]

23. Maran NJ, Glavin RJ. Low- to high-fidelity simulation – a continuum of medical education? Med Educ 2003;37(1):22-8.

Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review[24]

24. Issenberg S, McGahie W, Petrusa E, Lee Gordon D, Scalese R. Features and uses of high-fidelity simulation that lead to effective learning: a BEME systematic review. Med Teach. 2005 Jan;27(1):10-28.

BEME systematic review

- Best Evidence Medical Education (BEME) review
- Synthesized evidenced addressing the question, "What are the features and uses of high-fidelity medical simulation that lead to most effective learning?"
- Analyzed 670 journal articles published over 34 years
- 109 articles sufficiently robust to be included in analysis
- Concluded that high-fidelity simulation facilitates learning under the right conditions, including . . .

BEME systematic review

- **1 Providing feedback**
- **2 Repetitive practice**
- **3 Curriculum Integration**
- 4 Range of difficulty level
- 5 Multiple learning strategies

BEME systematic review

- 6 Capture clinical variation
- 7 Controlled environment
- 8 Individualized learning
- 9 Defined outcomes/benchmarks
- 10 Simulator validity

"The research evidence is clear that high-fidelity medical simulations facilitate learning among trainees when used under the right conditions"[24]

History of SIM in EMS

- Still in its infancy
- Origins of SIM in EMS is now
- Composed of scant literature in various topic areas

Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study[25]

25. McKenna K, Carhart E, Bercher D, Spain A, Todaro J, Freel J. Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study. Prehosp Emerg Care. 2015 Jul-Sep;19(3):432-40.

SUPER Study

- Cross-sectional survey
- Characterized the use of simulation in initial paramedic education programs
- Provided snapshot of what sim resources programs have (or have access to) and how they are used
  - Faculty perceptions about simulation
  - What influences sim use
    - Faculty training, program characteristics, resources

SUPER Study

- Cross-sectional census survey of 638 paramedic programs
  - Accredited by the Commission on Accreditation of Allied Health Education Programs (CAAHEP), or
  - Holding a letter of review
- 56 multiple-choice and open-ended questions
- 389 valid responses (61%) response rate

SUPER Study: Sim Resources

- 100% [programs] have/access to trainers (97% use)
- 100% have/access simple manikins (92% use)
- 100% have/access to intermediate manikins (93% use)
- 91% have/access to advanced manikins (71% use)
- 31% of programs w/ sim equipment that sits idle/unused

TABLE 2. Reasons simulation equipment sits idle and unused

Resource	n (%)
Inadequate training	31 (26)
Inadequate personnel	23 (19)
Inadequate time	17 (14)
Inadequate technical resources	13 (11)
Other department will not allow	3 (3)
No space to set up	3 (3)
Other	31 (26)

Reasons for idle equipment in the "other" category included class scheduling or sequencing, staff resistance or lack of confidence, equipment that was broken or outdated, and others.

TABLE 4. Simulation personnel resources availability

Type of support	n (%)
Simulation lab support (programming, AV, set-up)	89 (23)
Simulation lab operators (run the computers)	80 (21)
Manikin maintenance	78 (20)
Equipment manager	75 (19)
Other	18 (5)
None	216 (56)

"To ensure simulation is used effectively, programs must have the appropriate equipment, faculty training, and resources. If any of these elements is missing . . . programs are less likely to use simulation."[25]

SUPER Study

- Factors significantly associated w/ underuse of sim:
  - Faculty training
  - Equipment
  - personnel

NAEMSE Vision Paper on Simulation in EMS Education[26]

- Intent:
  - Help build a more complete body of knowledge regarding use of simulation in EMS
  - Uncover barriers to effective implementation
  - Outline recommendations for improvement

26. NAEMSE Vision Paper on Simulation in EMS Education. http://naemse.org/?page=documents (accessed May 19, 2016)

"Given an increased focus on patient safety, the need for standardized, on-demand educational opportunities to help ensure "road readiness," and the ability to practice and hone skills in a controlled environment, simulation has become an increasingly important tool in EMS education and skill acquisition."[26]

Scope & Challenges of EMS Education[26]

- Competencies required for EMS professions relatively consistent . . . education/training requirements aren't
- Progress made toward standardizing EMS Education
  - National EMS Education Standards (2009)
    - Define min entry-level educational competencies for each level of EMS as identified in National EMS Scope of Practice Model
    - Outcomes-based approach has largely replaced the National Standard Curricula
- Despite progress, inconsistent education/training/scope of practice remain a challenge of EMS education today

Scope & Challenges of EMS Education[26]

- Faculty training
  - Must be proficient in instilling evidenced-based clin skills
  - Also in developing experiential learning activities that lead to true student mastery
- Faculty workload
  - Overworked with multiple responsibilities
  - ~40% report dissatisfaction w/ workload
- Access to clinical sites
  - Competition for access to diverse patient population
  - Competition for access to diverse procedural skill practice

Scope & Challenges of EMS Education[26]

- Most significant challenge facing today's EMS educators is likely increased diagnostic focus
  - Requires EMS professional to adopt more complex roles
  - Most prevalent is rise of Mobile Integrated Healthcare (MIH)
    - Community paramedicine
    - Requires honing evaluation and diagnosis skills
    - Requires increased knowledge base
    - Shifts emphasis from short-term emergency care to longer-term support and education
    - Role necessitates additional training
- EMS is increasing its value in the community – and risk

Barriers to implementing simulation

Barriers to implementing simulation[26]

- Comment on SUPER study
  - Most paramedic programs w/ access to HFS (91%)
  - 78% called for more sim in their programs
  - Yet, only 71% of programs use them
- Disconnect exist between simulation resource acquisition and implementation . . . Consider the following

Barriers to implementing simulation[26]

- Faculty training
  - Less than half of respondents in SUPER study (48%) indicated their training was adequate
  - May be 2/2 many demands on faculty time
  - Difficult to keep pace w/ current evidence in clinical practice
- Insufficient personnel resources
  - >50% programs in SUPER study report no staff support for sim beyond regularly scheduled faculty hours
  - 19% cite inadequate personnel as reason sim equipment lay idle

Barriers to implementing simulation[26]

- Lack of equipment across the patient life span
  - Lack of child, infant, neonate sim resources
  - Difficult to determine impact of lack of appropriate age-related sim resources on learning outcomes
- Shared resources
  - Programs that share resources, was associated with a significant reduction in their use (have vs.. have access)
- Inadequate funding

Trends influencing simulation in EMS education

Trends influencing sim in EMS education[26]

- Research shows exposure to pts in clinical environment w/ ad hoc education sessions no longer sufficient to create competent healthcare practitioners
- Competition for clinical sites
- Limited patient encounters
- Focus on patient safety
- Increasing technology to provide standardized curriculum

Trends influencing sim in EMS education[26]

- Inconsistent clinical opportunities/patient encounters
  - Competition w/ other (discipline) students for opportunities
  - Sim allows replication of clinical encounters
  - Nursing data show sim is effective for end-of-program educational outcomes for graduates
- Progression of critical thinking skills
- Risk reduction

Recommendations

Recommendations for administrators, program directors and deans[26]

1. Ensure adequate # educated faculty w/ training and expertise in pedagogy of simulation
2. Include operational support staff as part of sim team
3. Budget annually for faculty development in sim . . .
4. Support development of sim leaders in faculty
5. Encourage collaboration w/ educators

Recommendations for EMS Educators[26]

1. Integrate sim into EMS curricula w/ clear connections to student learning outcomes
2. Use evidence-based practices to ensure facilitator competence in all aspects of simulation education
3. Pursue development of expertise as a simulation leader
4. Partner w/ other disciplines to create interprofessional simulation experiences
5. Use valid/reliable instruments for assessment in sim

Areas of simulation use in EMS post-graduate education & training

Simulation in EMS: CPR

- CPR quality and performance
  - Paramedic[2] vs. Paramedic-EMT (no sig diff in quality/errors)[27]
  - Positioning effects on CPR quality (single rescuer overhead)[28]
  - Effect of crew size on CPR performance (decr time to intubation w/ incr crew size, no diff in CPR effectiveness)[29]
- Education and Leadership training
- Devices
  - Evaluation of Autopulse® during extrication of simulated patients (increases compression fraction during extrication/transport)[30]

27. Bayley R, Weinger M, Meador S, Slovis C. Impact of ambulance crew configuration on simulated cardiac arrest resuscitation. Prehosp Emerg Care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir. 2008Mar;12(1):62-8.
28. Maloth S, Ganson E, Blith A, Goetz A, Schmidt G. Comparison of over-the-head, lateral and alternating positions during cardiopulmonary resuscitation performed by a single rescuer with bag-valve-mask device. Emerg Med J 2011 Nov;28(11):974-8.
29. Effect of crew size on objective measures of resuscitation for out-of-hospital cardiac arrest. Prehosp Emerg Care Off J Natl Assoc EMS Physicians Natl Assoc State EMS Dir. 2010Apr-6;14(2):229-34.
30. Lyon R, Crawford A, Crookston C, Short S, Gegg G. The combined use of mechanical CPR and a carry sheet to maintain quality resuscitation in out-of-hospital cardiac arrest patients during extrication and transport. Resuscitation. 2015Aug;93:102-6.

Simulation in EMS: Airway

- Evaluation and training
- Evaluation of airway devices
  - Video laryngoscope comparisons in sim difficult airways[31]
  - Pediatric airway device use
  - ETT w/ and w/o PPE[32]
- Initial airway training (SIM vs.. OR training)[33]
- Evaluation of practitioner performance

31. Butchart A, Tjen C, Garg A, Young P. Paramedic laryngoscopy in the simulated difficult airway: comparison of the Venner A.P. Advance and Glidescope Ranger video laryngoscopes. Acad Emerg Med. 2011 Jul;18(7):692-8.
32. Burns J, Brannon R, Barnes S, Tsueli B. Emergency airway placement by EMS providers: comparison between the King LT supralaryngeal airway and endotracheal intubation. Preshop Disaster Med. 2010 Jan-Feb;25(1):92-5.
33. Hall R, Plant J, Bands C, Wall R, Kang J, Hall C. Human patient simulation is effective for teaching paramedic students endotracheal intubation. Acad Emerg Med. 2005 Sep;12(9):850-5.

Simulation in EMS: Trauma

- Procedural competency
  - Navy: cadaver vs.. lecture training for needle thoracostomy (correctly placed: 75% cadaver vs.. 35% lecture group)[34]
  - Airway, Intraosseus line placement training
  - Military combat casualty care training (live tissue training vs.. high-fidelity simulator)[35]
- Training and Assessment
- Incorporation in ATLS courses[36]
- Cognitive skills and error identification

34. Grabo et al. Optimal training for emergency needle thoracostomy placement by prehospital personnel: Didactic teaching vs. .cadaver-based training program. J Trauma And Acute Care Surg 77.3 2014:S109-113.
35. Savage L, et al. A comparison of live tissue training and high-fidelity patient simulator: A pilot study in battlefield trauma training. J of Trauma 2015
36. Kim T, Neibling E, Denmark K. Student perception of high fidelity medical simulation for an international trauma life support course. Prehosp Disast Med 27.01 (2012):27-30.

Simulation in EMS: Education

- Evaluating competency
  - Simulation enhanced stroke course (improved recognition and management of stroke pts in sim)[37]
  - Simulation as a supplement to field evaluation[38]
  - Video observations of simulated scenarios
  - Error evaluation
- Educational courses/disaster training[39]
- Computer/virtual education/training (second life)
- Interdisciplinary teamwork/military

37. Gordon D, Issenberg S, Gordon M, LaCombe D, McGaghie W, Petrusa E. Stroke training of prehospital providers: an example of simulation-enhanced blended learning and evaluation. Med Teach. 2005 Mar;27(2):114-21.
38. Studnek J, Fernandez A, Shimberg B, Garifo M, Correll M. The association between emergency medical services field performance assessed by high-fidelity simulation and the cognitive knowledge of practicing paramedics. Acad Emerg Med. 2011 Nov;18(11):1177-85.
39. Idrose A, Adnan W, Villa G, Abdullah A. The use of classroom training and simulation in the training of medical responders for airport disaster. Emerg Med J. 2007 Jan;24(1):7-11.

Simulation in EMS: HEMS

- Simulation to teach/assess intubation for air medical providers (increases airway success rates in sim)[40]
  - Other studies demonstrate improved ETT performance w/ sim
- Evaluation of performance of equipment
  - Accuracy of AED on rhythm interpretation in flight[41]
  - Standard stethoscope vs.. estethescope in flight
  - Direct laryngoscopy vs.. video laryngoscopy in flight[42]
- High-fidelity sims in helicopters
- High fidelity HEMS simulators (Christoph Life – Germany)

40. Davis D, Buono C, Ford J, Paulson L, Koenig W, Garrison D. The effectiveness of a novel, algorithm-based difficult airway curriculum for air medical crews using human patient simulators. Prehosp Emerg Care. 2007 Jan-Mar;11(1):72-9.
41. Je S, You J, Chung T, Park Y, Chung S, Park I. Performance of an automated external defibrillator during simulator rotor-wing critical care transports. Resuscitation. 2011 Apr;9(2):81-4.
42. Grover J, Lubin J, Finney A, Tietjen K. The use of video laryngoscopy during air medical transport: a manikin study. Simul Healthc. 2013 Aug;8(4):229-33.

Simulation in EMS: Tactical EMS

- Video vs.. optical vs.. DL by experienced tactical medics[43]
- Impact of sleep deprivation on military naval officers ability to anticipate tactical problems in simulated combat operation (impaired ability to foresee tactical problems)[44]
- Comparison of field tourniquets during application in tactical simulations[45]
- Hemostasis training in Tactical Combat Casualty Care
- Military VR simulations

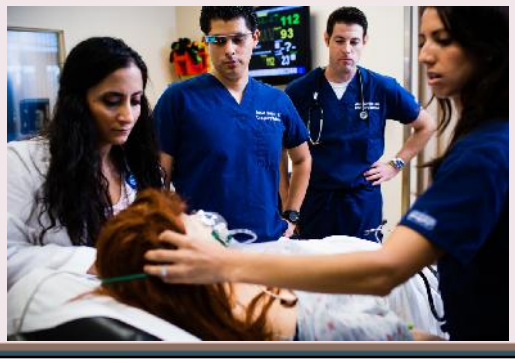
43. Yun B, Brown C, Grazioso C, Pozner C, Raja A. Comparison of video, optical, and direct laryngoscopy by experienced tactical paramedics. Prehosp Emerg Care. 2014 Jul-Sep; 18(3):442-5.
44. Olsen OK, Pallesen S, Espevik R. The impact of partial sleep deprivation on military naval officers' ability to anticipate moral and tactical problems in a simulated Maritime combat operation. Mil Psychol Marit Health. 2013;64(2):61-5.
45. Savage E, Pannell D, Payne E, O'Leary T, Tien H. Re-evaluating the field tourniquet for the Canadian Forces. Mil Med. 2013 Jun;178(6):669-75

Simulation in EMS: Disaster

- Simulated biological outbreak → disaster response[46]
  - Ability to identify shortcomings in disaster plans
- Prehospital mass casualty training[47]
  - Virtual reality + high-fidelity simulation
- Disaster drills (sim vs.. table-top exercises)
- WMD scenarios[48]
- Online multiplayer simulation exercises (CBRNE)

46. Klein K, Atas J, Collins J. Testing emergency medical personnel response to patients with suspected infectious disease. Prehosp Disaster Med. 2004 Jul-Sep;19(3):256-65.
47. Wilkerson W, Avstreih D, Gruppen L, Beier K, Woolliscroft J. Using immersive simulation for training first responders for mass casualty incidents. Acad Emerg Med. 2008 Nov;15(11):1152-9.
48. Kobayashi L, Suner S, Shapiro M, Jay G, Sullivan F, Overly F, Seefeld C, Hill A, Williams K. Multipatient disaster scenario design using mixed modality medical simulation for the evaluation of civilian prehospital medical response: a "dirty bomb" case study. Simul in Healthcare. 2006 Summer;1(2):72-8.

Simulation at UC Irvine



Simulation at UC Irvine – International EMS Simulation

Sim in EMS take home points

- Simulation is an innovative educational delivery method that can add value to learners if correctly implemented
- The major benefits of simulation are:
  - Feedback
  - Repetition of practice
  - Curriculum integration
- Simulation in EMS is in its infancy and primed for advances in education and research

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