

WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care**Worksheet author(s)**

Franklin HG BRIDGEWATER

Date Submitted for review:

20 October 2009

Clinical question.

"In providers (lay or HCP) (P), does undertaking CPR/AED training/performance of actual CPR or usage of an AED (I) compared with no such training/performance (C) increase harm (e.g. infection or other adverse events) (O)?"

Is this question addressing an intervention/therapy, prognosis or diagnosis?

The question addresses an intervention/therapy.

State if this is a proposed new topic or revision of existing worksheet:

International guidelines for resuscitation published in 2005 recognized the essential link between cardiopulmonary resuscitation (CPR) and defibrillation with an automated external defibrillator (AED) as elements of basic life support (Anonymous, 2005, IV1) (Handley, 2005, S7). The remote possibility of disease transmission from CPR was noted together with a fire hazard associated with the use of an AED (Anonymous, 2005, IV1). This worksheet will address the question posed above. It will include and utilize the data submitted on the subject to the 2005 International Consensus on CPR and ECC Science with Treatment Recommendations (Bridgewater, 2005, Bridgewater, 2005) and review data available from January 2004 until January 2009 relating to both the training for, and the performance of, CPR.

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? **No**

Search strategy (including electronic databases searched).**Search 1**

EBM 1980-2008 Week 39

a.

1. Intervention - CPR and Training

(Resuscitation/ OR cardiopulmonary arrest/ or heart arrest/ OR cardio?pulmonary resuscitation.mp. OR cardiac life support.mp. OR heart arrest.mp. OR resuscitat*.mp. OR cpr.mp. OR basic life support.mp.) AND (PARAMEDICAL EDUCATION/ or CONTINUING EDUCATION/ or ATHLETIC TRAINING EDUCATION/ or EDUCATION PROGRAM/ or RESEARCH BASED NURSING EDUCATION/ or RESIDENCY EDUCATION/ or INTERDISCIPLINARY EDUCATION/ or ALLIED HEALTH EDUCATION/ or EMERGENCY MEDICAL SERVICES EDUCATION/ or ADULT EDUCATION/ or OCCUPATIONAL THERAPY EDUCATION/ or EDUCATION/ or CLINICAL EDUCATION/ or NURSING EDUCATION/ or VOCATIONAL EDUCATION/ or CONTINUING EDUCATION PROVIDER/ or PATIENT EDUCATION/ or MEDICAL EDUCATION/ or HEALTH EDUCATION/ or SCHOOL HEALTH EDUCATION/ OR education program/ or in service training/ or teaching/ OR learning/ OR course*.

mp. OR educat*.mp. OR teach*.mp. OR learn*.mp. OR patient simulat*.mp. OR manikin*.mp. OR anatomic model*.mp. OR taught.mp. OR instruct*.mp. OR mannequin*.mp. OR simulat*.mp. OR dummy.mp.) 6065

2. Outcome

safety/ OR RISK MANAGEMENT/ or INFECTION RISK/ or RISK/ OR infection/ or communicable disease/ or cross infection/ OR Disease Transmission/ OR "General Aspects of Disease"/ OR (wounds and injuries).mp. OR (THORAX INJURY/ or INTESTINE INJURY/ or TRACHEA INJURY/ or ACCIDENTAL INJURY/ or LUNG INJURY/ or SPLEEN INJURY/ or LIVER INJURY/ or BRONCHUS INJURY/ or MUSCULOSKELETAL INJURY/ or SHOULDER INJURY/ or TISSUE INJURY/ or NEEDLESTICK INJURY/ or NERVE INJURY/ or CERVICAL SPINE INJURY/ or DUODENUM INJURY/ or INJURY/ or NECK INJURY/ or DIAPHRAGM INJURY/ or ROTATOR CUFF INJURY/ or SKIN INJURY/ or HEART INJURY/ or ELBOW INJURY/ or HEART MUSCLE INJURY/ or ARM INJURY/ or PERIPHERAL NERVE INJURY/ or ESOPHAGUS INJURY/ or CAROTID ARTERY INJURY/ or LIMB INJURY/ or SOFT TISSUE INJURY) OR Mental Stress/ OR

Infection Control/ OR Risk Factor/ OR Virus Infection/ OR Bacterial Infection/ OR Communicable Disease/ OR safe*.mp. OR risk*.mp. OR disease*.mp. OR adverse.mp. OR pathogen*.mp. OR hazard*.mp. OR stress*.mp. OR harm*.mp. OR infect*.mp. OR infect*.mp. OR injur*.mp. OR contaminat*.mp. 4202077

3. CPR AND Outcome 23883

4. CPR AND Training AND Outcome 3419

5. CPR NOT Training 37045

6. CPR NOT Training AND Outcome 204264

7. Population

exp health care personnel/ or health auxiliary/ or nursing home personnel/ or hospital physician/ or medical staff/ or resident/ or medical personnel/ or medical student/ or physician/ or paramedical personnel/ or nonmedical occupations/ OR Nurse/ OR Emergency Health Service/ or Health Care Personnel/ or Rescue Personnel/ or Emergency Medicine/ OR bystander.mp. OR rescuer.mp. OR first aider.mp. OR (Paramedical Personnel/ or first responder.mp. or Emergency Health Service/ or Fire Fighter/) OR Voluntary Worker/ OR lay.mp. OR laity.mp. 288389

8. CPR NOT Training AND Outcome AND Population 2090

9. CPR NOT Training AND Outcome AND Population (human & English) 1722

10. CPR AND Training AND Outcome AND Population 804

This search was repeated subsequently with a total of 862 articles. All abstracts were reviewed.

b. Twenty six articles were retrieved. Five were deemed relevant for inclusion. Two articles were noted to have already been detailed in the C2005 worksheet.

Search 2

PubMed

a. Search using the following terms

(((Cardiopulmonary resuscitation)) AND ((Education))) AND ((Adverse effects))

(("cardiopulmonary resuscitation"[MeSH Terms] OR ("cardiopulmonary"[All Fields] AND "resuscitation"[All Fields]) OR "cardiopulmonary resuscitation"[All Fields]) AND ("education"[Subheading] OR "education"[All Fields] OR "educational status"[MeSH Terms] OR ("educational"[All Fields] AND "status"[All Fields]) OR "educational status"[All Fields] OR "education"[All Fields] OR "education"[MeSH Terms])) AND ("adverse effects"[Subheading] OR ("adverse"[All Fields] AND "effects"[All Fields]) OR "adverse effects"[All Fields])

Translations:

Cardiopulmonary resuscitation	"cardiopulmonary resuscitation"[MeSH Terms] OR ("cardiopulmonary"[All Fields] AND "resuscitation"[All Fields]) OR "cardiopulmonary resuscitation"[All Fields]
Education	"education"[Subheading] OR "education"[All Fields] OR "educational status"[MeSH Terms] OR ("educational"[All Fields] AND "status"[All Fields]) OR "educational status"[All Fields] OR "education"[All Fields] OR "education"[MeSH Terms]
Adverse effects	"adverse effects"[Subheading] OR ("adverse"[All Fields] AND "effects"[All Fields]) OR "adverse effects"[All Fields]

This search produced a total of 55 articles.

b. All abstracts were reviewed. Eleven articles were retrieved. **Two** were finally relevant. Two others had been detailed in the worksheet for C2005.**Search 3**

OVID forward search

a. Consolidate bibliographies for relevant worksheets submitted to C2005 viz.

<http://www.americanheart.org/downloadable/heart/1105481470691i.traineeadverse.fhb.11dec04Final.pdf> (accessed 2 February 2009) and<http://www.americanheart.org/downloadable/heart/1098992888215b.responderadverse.FHB.26Aug04final.pdf> (accessed 2 February 2009)

This produced 110 references

b. Search Ovid Advanced Search -Ovid MEDLINE(R) 1950 to November Week 3 2008 for each reference

This located 99 of the 110 references

b. Find citing articles for each of those 99 retrieved references

Twenty five references had not been cited again. Of the seventy four references cited subsequently, thirty four articles published before 2004 had been cited 291 times and forty articles published after 2004 had been cited 147 times

c. Review titles and abstracts of 147 articles after 2004. Fourteen articles were retrieved. **Four** were considered relevant.**Search 4**References cited by articles retrieved from Searches 2 and 3 were scanned. Twenty six references were retrieved. **Six** were relevant. Four others had been detailed in C2005.**Search 5**Individual articles encountered in the search process were assessed and retrieved when considered appropriate. **Fifteen** references were finally deemed relevant.**Search 6**On 25 September 2009, The strategy of Search 1 was repeated. One hundred and forty one new articles were retrieved for a period commencing prior to the date of Search 1 first being conducted. Titles were reviewed and possibly relevant abstracts read. Articles incidentally encountered were reviewed and associated references retrieved. **Five** references were added to the data base.**Search 7**

On 25 September 2009, the search strategy for Search 2 was repeated. Three new articles were retrieved for a period commencing prior to the date of Search 2 first being conducted. Titles were reviewed and possibly relevant abstracts read. No references were relevant.

Search 8On 20 October, 2009, notification was received of a relevant article in press. This cited two further relevant articles **Three** articles were added to the reference base.**• State inclusion and exclusion criteria:****Types of studies**

Peer-reviewed studies indexed in PubMed and EMBASE were included for review. Where appropriate, additional relevant non-peer-reviewed published material in the form of letters, conference material, commentary, editorials and abstracts were included as background information.

Participants

Surgeons, surgical trainees (residents), physicians, allied health professionals, paramedical staff, nurses, medical students, or other people involved in CPR.

Only studies that reported on CPR/AED training, or reported on the performance of CPR/AED were included.

New intervention

CPR/AED training, or CPR/AED performance.

Comparative intervention

No CPR/AED training.

Outcomes

Studies that reported the following outcomes were included

Safety of the person performing CPR/AED which could include, but not be limited to Infection /injury.

Searches were conducted without language restriction. Foreign language papers were subsequently excluded unless the findings provided additional information over that reported in well designed studies published in the English language.

Articles were selected if the title or abstract contained information on CPR/AED. All study types were considered for inclusion. Articles were retrieved if they were judged to possibly meet the inclusion criteria. The researcher applied the selection criteria. In some cases, when the full text of the article was retrieved, closer examination revealed that it did not meet the inclusion criteria specified by the protocol. Consequently, these papers were not used to formulate the evidence base for the systematic review.

The reviewer noted that citations identified in the C2005 searching were not identified in the 2008 searching. There are reasons to account for this. Firstly, the searching performed in C2005 was more ad hoc than the systematic search recently performed. Hence, the reviewer may have searched opportunistically for a variety of text words which were not included in the 2008 searching. Secondly, the medical subject headings (MeSH) are revised annually by the National Library of Medicine. It may be that some of the MeSH searches performed in 2005 were invalid in the 2008 searching, and it cannot be assumed that automatic mapping captured the new MeSH.

Most of data retrieved did not meet the requirements of the present definitions for Levels of Evidence. Such data was necessarily placed at the lowest Level of Evidence i.e. LOE5.

• **Number of articles/sources meeting criteria for further review:**

Forty newly identified articles were finally considered relevant to the question [LOE1-1 (Hallstrom, 2004, 637) ;LOE2-3(Ingram, 2006, 89, Moser, 2000, 270, Sigsbee, 1990, 662),; LOE4-13 (Jones, 2004, 63) (Jones, 2005, 332) (Cheung, 2009) (Ahmad, 1990, 787, Cappato, 2006, 553, Hosmans, 2008, 216, Lloyd, 2008, 2510, McDaniel, 1988, 2029, Messmer, 1993, 217, Page, 2000, 1210, Peberdy, 2006, 59, Riegel, 2006, 98, Thierbach, 2005, 185),; LOE5-23 (Anonymous, 2005, IV1, Anonymous, 2005, IV 19, Anonymous, 2005, IV 35, Bridgewater, 2005, Bridgewater, 2005, Chalumeau, 2005, e29, Dickinson, 2008, 489, Handley, 2005, S7, Jorgenson, 2003, 225, Kerber, 2008, 2435, Koksai, 2002, 740, Macauley, 1978, 17, Nelson, 1979, 28, Schratler, 2007, 420, Siniorkakis, 2009, 293, Tarantola, 2006, 367, Theodorou, 2003, 677, Yeager, 1990, 51) (Gibbs, 1990, 101) (Hoke, 2009, 395) (Lechleuthner, 1995, 253) (Perkins, 2008, 1) (Sullivan, 2008, e712: author reply e713)]. These were then supplemented to the 110 in the C2005 worksheet. They are indicated by an asterisk (*) in the document. **Articles retrieved after C2005** **Articles retrieved in final search before submission.**

Evidence Supporting Lack of Harm of CPR/AED Training/Implementation

<p>Good</p>		<p>* (Ingram, 2006, 89) HQS</p>	<p>* (Riegel, 2006, 98)HQS</p>	<p>(Anonymous, 2000, 29)JPQRST (Anonymous, 2000, 29)JPQRST * (Anonymous, 2005, IV1)JPQRST * (Anonymous, 2005, IV 19)JPQRST * (Anonymous, 2005, IV 35)JPQRST * (Bridgewater, 2005, Bridgewater, 2005)G(Evb)JPQRST (Mejicano, 1998, 813)G(Evb)T (Osterholm, 1979, 1263)HPT * (Schratter, 2007, 420)IQR (Sepkowitz, 1996, 826, Sepkowitz, 1996, 917)G(Evb)T</p>
<p>Fair</p>	<p>* (Hallstrom, 2004, 637) HQRS</p>	<p>(Dracup, 1997, 1434) HPS * (Moser, 2000, 270) HPS (Moser, 1999, 326)HPS * (Sigsbee, 1990, 662)</p>	<p>(Anonymous, 1978, 247)HPT (Axelsson, 1996, 3, Axelsson, 1998, 13)LQ (Glaser, 1985, 1653)HPT * (Lloyd, 2008, 2510)HQS (McCray, 1986, 1127)HT * (McDaniel, 1988, 2029)HPS (McLauchlan, 1992, 7) HPS (Marcus, 1988, 1118)HT (Miller, 1982)LPR * (Peberdy, 2006, 59)HQRS</p>	<p>(Achong, 1979, 1025, Achong, 1980, 759) NQT;(Anonymous, 1979, 14)JPT; (Anonymous, 1986, 2905)JT; (Anonymous, 1987, 1S)JT;(Anonymous, 1989, 2714)JT; (Anonymous, 1989, 3)JT; (Anonymous, 1990, 1007)O; (Anonymous, 1992, 2195)JT; (Anonymous, 1997, 1)JT; (Anonymous, 1998, B3)K;(Anonymous, 1998, 1870)JQ; (Arend, 2000, 73)G(Evb)T;(Baker, 1999, 155)G(Narr)R;(Baskett, 1993, 1)G(Narr)T (Becker, 1997, 2102)G(Narr)T;(Bierens, 1996, 185)GQT;(Blenkharn, 1990, 151)IT (Blenkharn, 1992, 624)NQT (Cavagnolo, 1985, 456)IPT (Corless, 1992, 1542)IPT (Cummins, 1989, 2732)GK (Cutler, 1979, 1074)NQ (Cydulka, 1991, 317)IQT; (Deetz, 1979, 912)NPT * (Gibbs, 1990, 101)LPQR * (Handley, 2005, S7)JPQRST * (Hoke, 2009, 395)GPQR (Hudson, 1983, 485, Hudson, 1984, 1108)IPT * (Kerber, 2008, 2435)O (Lambrew, 1979, 44)NPT (Lyster, 2003, 307)IQR * (Macauley, 1978, 17)HPT (Montgomery, 1986, 2990)O (Nickalls, 1986, 1350)NQT (Ornato, 1989, 45)G(Narr)T * (Perkins, 2008, 1)OQRST (Rinker, 2001, 89)G(Narr)PQS (Sande, 1986, 380)OT (Saviteer, 1985, 1606)HNQT, (Stern, 1994, 85)M, (Sun, 1995, 205)G(Narr)PT (Swanson, 1993, 350)G(Narr)QS * (Tarantola, 2006, 367)G(Evb)T (Wenzel, 2001, 123)G(Narr)T (West, 1990, 28)NT</p>
<p>Poor</p>			<p>* (Cappato, 2006, 553)HQRST * (Messmer, 1993, 217)HPS * (Page, 2000, 1210) * (Capucci, 2003, 12)HQRST</p>	<p>(Ahmad, 1990, 787)EHQ * (Jorgenson, 2003, 225)HQS * (Nelson, 1979, 28)G(Narr)PS</p>
	<p>1</p>	<p>2</p>	<p>3</p>	<p>4</p>
<p>5</p>				
<p>Level of Evidence</p>				

Evidence Neutral to Lack of Harm of CPR/AED Training/Implementation

Good				<p>* (Hosmans, 2008, 216)IQR *(Cheung, 2009)HQRS</p>	
Fair				<p>(Genest, 1990, 305)HQS (Laws, 2001, 76)HQS (Mannis, 1984, 64)HPT (Stacey, 2004, 75)HQR * (Thierbach, 2005, 185, Thierbach, 2003, 269)IQR</p>	<p>(Anonymous, 1990, 1)JT (Ballard, 1986, 198)LQT (Bass, 1994, 1359)G(Narr)T (Berumen, 1983, 253)NQS * (Chalumeau, 2005, e29)HT (Christian, 2004, 287)HT (Clements, 2003, 379)HQR (Cohen, 1985, 136)NPT (Davies, 1979, 593)NQ * (Dickinson, 2008, 489)HQR (Edwards, 2001, 378)L (Feldman, 1972, 1107)G(Narr) (Figura, 1996)HQT (Finkelhor, 1980, 650)HQT (Gamble, 2001, 157)G(Narr)QS (Gilston, 1979, 694)NQ (Greenberg, 1983, 194)HNP (Heilman, 1965, 1035)HQT (Hendricks, 1980, 257)HQT (Jacobson, 1976, 1053)MT (Khan, 1979, 2701)IPT *(Lechleuthner, 1995, 253)HQR (Lonergan, 1981, 793)IR (McCabe, 1997, 48K)G (Salzer, 1983, 195)NP (Shimokawa, 2001, 290)HQR (Steinhoff, 2001, 159)HQT *(Sullivan, 2008, e712; author reply e713)NQR (Sullivan, 2000, 64)HPR * (Siniorakis, 2009, 293) HQR * (Theodorou, 2003, 677)HQR (Todd, 1980, 331)HQT (Valenzuela, 1991, 90)HQT (Walker, 2001, 179)IR</p>
Poor				<p>(Genest, 1991)HQS</p>	<p>(Davis, 1978, 214)G(Narr)T *(Koksal, 2002, 740)HQR (Memon, 1982, 322)HPR (Neiman, 1982, 813)HPT (Nicklin, 1980, 2046)NPT *(Yeager, 1990, 51)OPQS</p>
	1	2	3	4	5
Level of Evidence					

Italics=Animal studies

G(Narr) = Review (Narrative)

G(Evb) = Review (Evidence-based)

H = Clinical report

I = Laboratory report

J = Guidelines

K= News report

L = Survey

M = Educational material

N = Correspondence

O = Position Statement

P = CPR Training

Q = CPR Performance

R = Adverse physical effect

S = Adverse psychological effect

T = Disease transmission

* = References added after 2005 submission

Evidence Opposing Lack of Harm of CPR/AED Training/Implementation

Good					
Fair				*(Jones, 2004, 63)LQR *(Jones, 2005, 332)LQR	
Poor					(Prosser, 1990, 3025)NPT
	1	2	3	4	5
Level of Evidence					

A = Return of spontaneous circulation
B = Survival of event
F = Other effect
H = Clinical report
K= News report
N = Correspondence
Q = CPR Performance
T = Disease transmission

C = Survival to hospital discharge
D = Intact neurological survival
G(Narr) = Review (Narrative)
I = Laboratory report
L = Survey
O = Position Statement
R = Adverse physical effect
*** = References added after 2005 submission**

E = Other endpoint
Italics = Animal studies
G(Evb) = Review (Evidence-based)
J = Guidelines
M = Educational material
P = CPR Training
S = Adverse psychological effect

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

[References added subsequent to the C2005 submission are indicated by an asterisk (*)]

1. ADVERSE PHYSICAL EVENTS

Reported adverse physical effects have included myocardial infarction (Memon, 1982, 322)], chest pain, allergic reaction, malaise (Greenberg, 1983, 194), pneumothorax (Sullivan, 2000, 64), interosseous nerve palsy (Shimokawa, 2001, 290), hyperventilation (Thierbach, 2003, 269) *(Thierbach, 2005, 185), hypocarbia (Walker, 2001, 179) and back injury *(Cheung, 2009) *(Jones, 2004, 63) *(Jones, 2005, 332). The concerns of Thierbach et al. and Walker & Liddle were addressed in Part 4: Adult Basic Life Support of the ILCOR/AHA Guidelines in 2005 *(Anonymous, 2005, IV1). Peberdy *(Peberdy, 2006, 59), detailing adverse effects associated with the PAD trial *(Hallstrom, 2004, 637), reported a single adverse physical event – a pulled muscle – in 239 events. Some data, based on a series of six physicians (aged 25-40 years) performing single-person CPR on a manikin, suggest that CPR might provoke ischemic symptoms in a rescuer with coronary artery disease (Lonergan, 1981, 793). Ingram et al. *(Ingram, 2006, 89), in studying psychological aspects of CPR training in cardiac rehabilitation patients, were aware of the physical nature of CPR training and advised participants accordingly and had resuscitation equipment available but there is no mention of its usage. Macauley *(Macauley, 1978, 17) reported on a CPR program which included a significant number of trainees with physical disabilities. One trainee developed tachypnoea after CPR practice and was found to have known (but undeclared) ischaemic heart disease. Poisoning is a potential problem rarely reported *(Koksal, 2002, 740) (Berumen, 1983, 253).

2. SCREENING TRAINEES

Memon, (Memon, 1982, 322), on the basis of a fatal myocardial infarct following CPR training, expressed an opinion that any person with known ischaemic heart disease should be excluded from participation in CPR training and that persons with risk factors for such should be asked to seek medical clearance before undertaking CPR training. Subsequently Greenberg (Greenberg, 1983, 194) noted a lack of risk awareness and ignorance of the physical nature of CPR training, and a “substantial” incidence of risk factors amongst CPR trainees. He had also observed an aggravation of pre-existing medical conditions in four cases. He suggested research into the physical demands of CPR, educating instructors in conducting a screening process before training and education of trainers and trainees in the risks associated with such activity. Salzer et al. (Salzer, 1983, 195), in partially addressing these suggestions, measured the energy expenditure of ten fit medical students while performing CPR. Their findings “tended to disconfirm (sic) our previous anxiety about CPR training in this test group.” Their practice was to advise potential trainees of the nature of the training to be undertaken and consequently advise them to assess, or have an assessment made, of their physical conditions prior to commencing CPR training.

3. SIGNIFICANCE OF AEDs

Defibrillation is part of BLS and automatic defibrillators (AEDs) are being more widely encountered in first responder and public access defibrillation settings. Data on the safety of AEDs in the first responder setting are limited. The earliest report of adverse effects is from 1990 *(Gibbs, 1990, 101) while the most recent by Hoke et al. includes risk associated with intentional and accidental mis-use *(Hoke, 2009, 395). Cappato *(Cappato, 2006, 553) claims safety with no data while Capucci *(Capucci, 2003, 12) and Jorgensen *(Jorgensen, 2003, 225) describe an absence of adverse events while Page et al *(Page, 2000, 1210) conclude that their experience “suggests that there is no basis for concern”. While the PAD trial *(Hallstrom, 2004, 637) spoke simply of safety and efficacy with few adverse effects associated with the use of an AED, these are subsequently detailed by Peberdy et al. *(Peberdy, 2006, 59) who noted occasional significant but usually transient emotional distress in the trained first responder. One physical adverse event (a pulled muscle) was recorded. Peberdy’s data does not allow differentiation between AED usage and non-usage. Stress reactions associated with the PAD trial were further analysed by Riegel et al. *(Riegel, 2006, 98) – low levels of stress were noted but again there was no differentiation between AED usage and non-usage. There are reports of resuscitators receiving minor shocks from use of an AED, the most recent being *(Dickinson, 2008, 489), but no reports of clinically significant shocks. Miller reports a series of incidents with external defibrillation affecting rescuers, a bystander and a helicopter pilot (Miller, 1982). Following the orthodox teaching, Hosmans et al *(Hosmans, 2008, 216) demonstrated “unsafe” behaviour during AED use. However the value of minimal interruption to compressions during CPR led to a study considering the safety of a rescuer remaining in contact with a patient being shocked with modern defibrillation equipment. The unorthodox possibility of uninterrupted chest compressions during shock delivery was then strongly posited *(Kerber, 2008, 2435) *(Lloyd, 2008, 2510). Kerber wrote “The study by Lloyd et al. should lead the American Heart Association to consider a modification of the 2005 Guidelines: Chest compressions may be safely continued through defibrillation provided that self-adhesive pad electrodes are used and gloves are worn”. Sullivan suggested caution *(Sullivan, 2008, e712; author reply e713) while Perkins regarded the work as a landmark *(Perkins, 2008, 1). Simulation of defibrillation in a wet environment “did not show significant risk should circumstances demand it” (Lyster, 2003, 307) Defibrillation associated with mild resuscitative hypothermia was considered in a laboratory setting using a pig model and an advanced surface cooling system using iced water. It was shown that defibrillation in this wet situation was safe and effective

*(Schratter, 2007, 420). Implanted cardioverter defibrillators have caused shocks by discharging during CPR *(Lechleuthner, 1995, 253), (Clements, 2003, 379), *(Siniorakis, 2009, 293). In this context, there has been no report located of fire since that detailed by Theodorou *(Theodorou, 2003, 677).

4. PSYCHOLOGICAL EFFECTS

Nelson *(Nelson, 1979, 28) foresaw benefit in training in CPR for family members of cardiac patients. Some benefit was confirmed by McDaniel et al *(McDaniel, 1988, 2029), Sigsbee *(Sigsbee, 1990, 662), and Moser and Dracup *(Moser, 2000, 270). CPR training had no adverse psychological effects for family members of patients with cardiac disease (Dracup, 1997, 1434) (McLauchlan, 1992, 7) (Moser, 1999, 326). MacLauchlan (McLauchlan, 1992, 7) taught CPR to high-risk patients with recurrent ventricular tachycardia and their relatives and, as noted above, Ingram *(Ingram, 2006, 89) has taught CPR to cardiac rehabilitation patients and relatives and both groups showed psychological benefit. Teaching mothers of cocaine-positive infants was deemed to be associated with an increase in the mother's self-esteem *(Messmer, 1993, 217). Adverse effects of performing CPR have been noted. These have included negative feelings (Axelsson, 1996, 3, Axelsson, 1998, 13), psychological stress (Gamble, 2001, 157), and critical incident stress (Laws, 2001, 76). Swanson refers to "serious consequences for emergency personnel who respond to a crisis" but accepts that "the paucity of data currently available prevents firm conclusions about the effects on emergency personnel and may not be relevant to more routine CPR attempts" (Swanson, 1993, 350). One study (Genest, 1990, 305) dealt with volunteer workers in unsuccessful attempts at CPR. Recognition of probable failure was not protective in itself and there was evidence of persisting psychological aftermaths with no respondent being entirely free from unbidden recollections of the experience. Peberdy et al *(Peberdy, 2006, 59) noted minor adverse psychological effects from the PAD trial and Riegel et al. *(Riegel, 2006, 98), assessing the stress on lay responders in the same trial, concluded that "low levels of stress were reported". Cheung et al. (Cheung, 2009) describe one psychological injury arising from participation in a MET response..

5. DISEASE TRANSMISSION

Isolated cases of confirmed disease transmission to the rescuer/trainee exist. These include Salmonella infantis (Ahmad, 1990, 787), PVL-producing Staphylococcus aureus *(Chalumeau, 2005, e29), SARS-CoV (Christian, 2004, 287), four of meningococcal disease (Feldman, 1972, 1107), herpes simplex (Finkelhor, 1980, 650) (Hendricks, 1980, 257), Mycobacterium tuberculosis (Heilman, 1965, 1035), shigella (Todd, 1980, 331) and Streptococcus pyogenes (Valenzuela, 1991, 90) while performing CPR and herpes simplex while training (Mannis, 1984, 64). Mejicano mentions a case of Helicobacter pylori transmission (Mejicano, 1998, 813) but this is an example of resuscitator-to-patient transmission (Figura, 1996) while two cases (Neiman, 1982, 813, Nicklin, 1980, 2046) are dubious. Tarantola *(Tarantola, 2006, 367) conducted a review of pathogens transmitted by occupational exposure: only one from that report related to CPR (Valenzuela, 1991, 90). In the absence of high risk activities such as cannulation, there has been no reported case of transmission of HepB, HepC, HIV or cytomegalovirus during either the performance of or training for CPR. In circumstances conducive to disease transmission, it has not occurred (Anonymous, 1978, 247) (Glaser, 1985, 1653) (Osterholm, 1979, 1263) (Perras, 1980, 118) (Saviteer, 1985, 1606). Over a 22 year period, the New York City Fire Department had no record of disease transmission through rescue breathing but there are no details provided of the number resuscitated in this period (Cutler, 1979, 1074). A critical examination of the data assigning risks to mouth-to-mouth resuscitation is important (Deetz, 1979, 912). There is a continuing need for accurate reporting of such adverse effects. Bierens presenting the rational approach for the risk of transmission of the AIDS virus concludes that the risk of sero-conversion due to CPR is about one per million resuscitations in the highest risk group and less than one per billion resuscitations in the group most often resuscitated. He states that volunteer life-savers "should know that if there is no blood visible, or if there is no open wound in the mouth of the rescuer, no blood-blood contact and thus no sero-conversion is possible even when the victim is sero-positive (Bierens, 1996, 185). A puncture wound during the performance of CPR from a sternotomy wire (Steinhoff, 2001, 159) highlighted the risk of disease transmission. Vaccination against hepatitis B is proposed for those with an occupational risk of exposure and disease transmission (Anonymous, 1990, 670) but it must be noted that, in this context, CPR has not been implicated in the transmission of this disease.

6. ROLE OF BARRIER DEVICES

As early as 1965 (Heilman, 1965, 1035) as a result of a case of TB transmission, it was suggested that some form of protection was needed to avoid the need for mouth-to-mouth contact when performing CPR. This concern remained in 1985 (Cohen, 1985, 136) and subsequently various guidelines and authors advocated their use (Nickalls, 1986, 1350) (Anonymous, 1987, 1S, Anonymous, 1989, 2714) (Baskett, 1993, 1) (Bierens, 1996, 185) (Hendricks, 1980, 257) accepting that their efficacy had not been demonstrated conclusively (Anonymous, 1990, 670). Some data suggested that certain devices possibly afforded protection against bacterial transmission (Blenkarn, 1990, 151) (Cydulka, 1991, 317). Both Sun (Sun, 1995, 205) and Mejicano (Mejicano, 1998, 813) reiterate the advice that such devices should be used despite no additional evidence of their efficacy in reducing disease transmission; there continues to be no data showing that these devices reduce disease transmission.

7. MANIKIN DISINFECTION

Early assessment of the efficacy of the technique of manikin disinfection focused on bacteria (Hudson, 1983, 485) and later assessments on viruses (Mannis, 1984, 64) (Hudson, 1984, 1108) (Cavagnolo, 1985, 456) (Corless, 1992, 1542). While these data show that the techniques of disinfection assessed are effective, there are no data confirming a consequent reduction in disease transmission.

8. POST-EXPOSURE MANAGEMENT

A rescuer who has given mouth-to-mouth ventilation to a patient with pulmonary tuberculosis should have serial tuberculin skin testing and should be offered prophylaxis if conversion occurs (Bass, 1994, 1359) (Mejicano, 1998, 813). Post exposure prophylaxis for Hepatitis B is only advocated for accidental percutaneous or per-mucosal exposure to HBsAg-positive blood (Anonymous, 1990, 1). For *Neisseria meningitidis*, antimicrobial prophylaxis is recommended for anyone directly exposed to the patient's oral secretions (e.g. through mouth-to-mouth resuscitation, endotracheal intubation, or endotracheal tube management). Rifampicin has been the drug of choice but ciprofloxacin or ceftriaxone are reasonable alternatives (Achong, 1979, 1025, Jacobson, 1976, 1053) (Anonymous, 1997, 1). The Centers for Disease Control Cooperative Needle-stick Surveillance Groups abandoned follow-up on health care workers exposed to saliva and other non-blood fluids from patients with HIV because none of 106 workers followed up for more than one year sero-converted (Cummins, 1989, 2732) (Marcus, 1988, 1118).

Acknowledgements:

Dr Peter Morley was always helpful and provided sound guidance, advice and encouragement. Guy Maddern, RP Jepson Professor of Surgery, The University of Adelaide, South Australia, provided access to retrieval facilities and staff at ASERNIP-S. Caryn Perera, Research Officer, ASERNIP-S helped in developing the prime search strategy and Sheona Page, Clinical Trial Coordinator, University of Adelaide, retrieved articles with alacrity and skill. Dr Chris Zeitz, Dr Ross Philpot and Marija Juraja RN, from The Queen Elizabeth Hospital, Woodville, South Australia, reviewed relevant aspects of the worksheet.

Citation List

References added subsequent to the 2005 submission are indicated by an asterisk (*)

Those added prior to final submission are highlighted in blue.

Achong MR. Hazards of mouth-to-mouth resuscitation. *Lancet* 1979;2(8150):1025 (Achong, 1979, 1025)
NQT

In response to (Davies, 1979, 593), Achong advocates an aggressive in hospital IV antibiotic regime for resuscitators exposed to N. meningitidis by mouth-to-mouth contact.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Achong MR. Infectious hazards of mouth-to-mouth resuscitation. *American Heart Journal* 1980; 100(5):759-61. (Achong, 1980, 759)

G(Narr) T

Reports (Heilman, 1965, 1035) (Davis, 1978, 214, Feldman, 1972, 1107) (Osterholm, 1979, 1263) (Perras, 1980, 118) (Khan, 1979, 2701) and concludes that "the seemingly very small risk of transmission of infection from patient to operator during mouth-to-mouth resuscitation is no reason to abandon mouth-to-mouth resuscitation. However, more frequent documentation of the outcome of such contacts with patients harbouring various infections would allow a better appreciation of the risks involved."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Ahmad F, Senadhira DCA, Charters J, Acquilla S. Transmission of salmonella via mouth-to-mouth resuscitation. *Lancet* 1990; 335(8692):787-88. (Ahmad, 1990, 787)

EHQ

Case report of transmission of salmonella infantis by mouth-to-mouth resuscitation.

Level of Evidence: 5

Quality of evidence: Poor

Nature of Evidence: Supportive

Anonymous. Lack of transmission of hepatitis B after oral exposure to hepatitis B surface antigen-positive saliva. *MMWR - Morbidity & Mortality Weekly Report* 1978(27):247-48. (Anonymous, 1978, 247)

HPT

Recounts two incidents with exposure of 34 people in which transmission of Hepatitis B did not occur. It concludes "the risk of transmission of hepatitis B as a result of indirect oral contact with HBsAg-positive saliva appears to be small."

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Disinfection of C.P.R. training manikins. *Australian Nurses' Journal* 1979; 8(10):14-5. (Anonymous, 1979, 14)

JPT

A statement of recommendations from the Australian Resuscitation Council Newsletter.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Guidelines for the prevention of disease transmission in the use of CPR. Washington DC: National Research Council; 1984. (Anonymous, 1984)

NOT AVAILABLE AND NOT ASSESSED IN EVIDENCE

Anonymous. Standards and guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). National Academy of Sciences - National Research Council. [Erratum appears in JAMA 1986 Oct 3; 256(13):1727]. JAMA 1986; 255(21):2905-89. (Anonymous, 1986, 2905)

JT

Pages 2926-2928 cover "Safety in training for and providing CPR". It addresses in detail the matter of disease transmission but maintains a supportive stance for CPR. There is no mention of other hazards.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Recommendations for prevention of HIV transmission in health-care settings. MMWR - Morbidity & Mortality Weekly Report 1987; 36 Suppl 2:1S-18S. (Anonymous, 1987, 1S)

JT

This document is the basis for Universal Precautions. It states "Although saliva has not been implicated in HIV transmission, to minimize the need for emergency mouth-to-mouth resuscitation, mouth pieces, resuscitation bags, or other ventilation devices should be available for use in area in which the need for resuscitation is predictable."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Risk of infection during CPR training and rescue: supplemental guidelines. The Emergency Cardiac Care Committee of the American Heart Association. JAMA 1989; 262(19):2714-5. (Anonymous, 1989, 2714)

JT

Provides guidelines for

- *Rescuers with known or suspected infections*
- *Rescuers with a duty to provide CPR*
- *The layperson*
- *CPR training for infected individuals*
- *Individuals unable to complete a CPR course*

Additional references (Anonymous, 1986, 2905), (Sande, 1986, 380), (Anonymous, 1987, 1S), (Anonymous, 1987, 1S)

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers. [Erratum appears in MMWR Morb Mortal Wkly Rep 1989 Nov 3; 38(43):746]. MMWR - Morbidity & Mortality Weekly Report 1989; 38 Suppl 6:3-37. (Anonymous, 1989, 3)

JT

Notes no transmission of HBV or HIV infection but the risk of other infectious diseases is stated. They advocate disposable resuscitation equipment and ancillary airway devices.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. CDC issues guidelines for protection against viral hepatitis. Clinical Pharmacy 1990; 9(9):670. (Anonymous, 1990, 670)

Refers to 12. below.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Anonymous. Protection against viral hepatitis. Recommendations of the Immunization Practices Advisory Committee (ACIP). Morbidity & Mortality Weekly Report. Recommendations & Reports 1990; 39(RR-2):1-26. (Anonymous, 1990, 1)

JT

In the context of HBV infection:

- *It is proposed that persons with occupational risk be vaccinated pre-exposure.*
- *Post exposure prophylaxis is advocated for "accidental percutaneous or per-mucosal exposure to HBsAg-positive blood."*

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Anonymous. Disease transmission and cardiopulmonary resuscitation. Emergency Cardiac Care Committee, Heart and Stroke Foundation of Canada. CMAJ Canadian Medical Association Journal 1990; 143(10):1007-8. (Anonymous, 1990, 1007)

O

Refers to evidence for lack of transmissibility of HIV/AIDS and Hep B by saliva but notes spread of viral respiratory infections by M-M CPR. It accepts that "the value of CPR outweighs the small, theoretical risk of disease transmission." It advocates ready access to mechanical ventilation or barrier devices accepting that their efficacy has not been demonstrated conclusively (in 1990).

Concludes that "the value of CPR outweighs the small, theoretical risk of disease transmission".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: supportive

Anonymous. Guidelines for cardiopulmonary resuscitation and emergency cardiac care, Emergency Cardiac Care Committee and Subcommittees, American Heart Association Part. II. Adult basic life support (See Comment). JAMA 1992; 268:2195-7. (Anonymous, 1992, 2195)

JT

Provides recommendations for control of disease transmission during CPR training and outlines practices espoused for the performance of CPR.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Anonymous. Q & A: disinfecting Resusci Annes. *Healthcare Hazardous Materials Management* 1992; 5(9):11. (Anonymous, 1992, 11)

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Anonymous. Control and prevention of meningococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Recomm Rep* 1997; 46(RR-5):1-10. (Anonymous, 1997, 1)

JT

Antimicrobial prophylaxis is recommended for anyone directly exposed to the patient's oral secretions (e.g. through mouth-to-mouth resuscitation, endotracheal intubation, or endotracheal tube management). Rifampicin has been the drug of choice but ciprofloxacin or ceftriaxone are reasonable alternatives.

Level of Evidence: 5

Quality of evidence: Fair

Evidence: Supportive

Anonymous. AHA clarifies message on mouth-to-mouth component of CPR. *Arteriosclerosis, Thrombosis & Vascular Biology* 1998; 18(2):B3. (Anonymous, 1998, B3)

K

Report of (Becker, 1997, 2102) Includes quotation from Cummins RO "Don't worry about disease – worry about saving the person's life"

Level of Evidence: 5

Quality of evidence: Fair

Nature of Evidence: Supportive

Anonymous. The 1998 European Resuscitation Council guidelines for adult single rescuer basic life support. Basic Life Support Working Group of the European Resuscitation Council. [See comment][Erratum appears in *BMJ* 1998 Aug 22; 317(7157):501]. *BMJ* 1998; 316(7148):1870-6. (Anonymous, 1998, 1870)

J

In contrast to (Handley, 1998, 67) the document describes general risks (traffic and other environmental factors) and the specific concerns about poisoning, the possible but rare event of disease transmission and the need for effective ancillary devices. It notes that "Resuscitation manikins have been shown not to be a source of infection."

Level of Evidence: 5

Quality of evidence: Fair

Nature of Evidence: Supportive

Anonymous. Guidelines 2000 for Cardiopulmonary resuscitation and emergency cardiovascular care - An international consensus on science. *Resuscitation* 2000; 46(1-3):1-447. (Anonymous, 2000, 1)

JPQRST

The statement on page 60 referring to (Mejicano, 1998, 813) as a reference for transmission of *Neisseria gonorrhoeae* seems to be an error. Mejicano makes no reference to *N. gonorrhoeae* but only *N. meningitidis*.

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

Anonymous. Part 3: adult basic life support. European Resuscitation Council. Resuscitation 2000; 46(1-3):29-71. (Anonymous, 2000, 29)

JPQRST

An extract from the major publication of "International Guidelines 2000 for CPR and ECC – A Consensus on Science". (Anonymous, 2000, 1) listed above. Pages 59-61 focus on disease transmission during both training for and performance of CPR.

Note the comment on error concerning transmission of *N. gonorrhoeae* in (Anonymous, 2000, 1)].

Level of Evidence: 5

Quality of evidence: Good

Nature of Evidence: Supportive

***Anonymous.** 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005; 112(24 Suppl): IV 1-203. (Anonymous, 2005, IV1)

***Anonymous.** 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Part 4: Adult Basic Life Support. Circulation 2005; 112(24 Supplement): IV 19-34. (Anonymous, 2005, IV 19)

***Anonymous.** 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Part 5: Electrical Therapies Automated External Defibrillators, Defibrillation, Cardioversion, and Pacing Circulation 2005;112(24 Supplement):IV 35-46. (Anonymous, 2005, IV 35)

JPQRST

The index reference for the worksheet

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

Arend CF. Transmission of infectious diseases through mouth-to-mouth ventilation: Evidence-based or emotion-based medicine? Arquivos Brasileiros de Cardiologia 2000; 74(1):73-97. (Arend, 2000, 73)

G(Evb) T

The **objective of this article is to review the literature on infectious diseases transmitted** through mouth-to-mouth ventilation. The search for available scientific evidence for pre- and post-exposure prophylaxis has been made through searching the *Medline*: database of articles published between 1990-1999. In addition to this, all the articles published between 1966-1999 in journals indexed to *Index Medicus* with the key word *mouth-to-mouth ventilation* or *mouth-to-mouth ventilation*, and *cardiopulmonary resuscitation* were reviewed. Conclusions were also based on a personal collection of articles, posters and relevant notes collected over the last few years.

This review adds no new data or material for the interval since that of (Mejicano, 1998, 813)

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Axelsson A, Herlitz J, Ekstrom L, Holmberg S. Bystander-initiated cardiopulmonary resuscitation out-of-hospital. A first description of the bystanders and their experiences. *Resuscitation* 1996; 33(1):3-11. (Axelsson, 1996, 3)

LQ

In considering the psychological reactions, 7% of the respondents indicated some negative feelings about the CPR process but only 0.5% were uncertain about starting CPR again.

Level of Evidence: 4

Quality of evidence: Fair

Nature of Evidence: Supportive

Axelsson A, Herlitz J, Karlsson T, Lindqvist J, Graves JR, Ekstrom L, et al. Factors surrounding cardiopulmonary resuscitation influencing bystanders' psychological reactions. 1998. (Axelsson, 1998, 13)

LQ

This survey includes some of the cases from (Axelsson, 1996, 3)1990-1994. The results of the two surveys were similar with this providing some insight concerning this negative psychological reaction.

Level of Evidence: 4

Quality of evidence: Fair

Nature of Evidence: Supportive

Baker DJ. The pre-hospital management of injury following mass toxic release; a comparison of military and civil approaches. *Resuscitation* 1999; 42(2):155-59. (Baker, 1999, 155)

G(Narr) R

Simple reference made to "the need for protection of emergency responders"

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Ballard JL, Musial MJ, Myers MG. Hazards of delivery room resuscitation using oral methods of endotracheal suctioning. *Paediatric Infectious Disease* 1986; 5(2):198-200. (Ballard, 1986, 198)

LQT

A documentation of practice and hazards in the late 1970s and early 1980s. May overstate the case when saying the risk is considerable.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Baskett PJF. Ethics in cardiopulmonary resuscitation. *Resuscitation* 1993; 25(1):1-8. (Baskett, 1993, 1)

G(Narr) T

The discussion on risks of disease transmission refers to the known reported incidents and the lack of transmission of HBV and HIV/AIDS and the need for good cleaning techniques and practice in training sessions.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Bass JB, Jr., Farer LS, Hopewell PC, O'Brien R, Jacobs RF, Ruben F, et al. Treatment of tuberculosis and tuberculosis infection in adults and children. American Thoracic Society and The Centers for Disease Control and Prevention.[see comment]. American Journal of Respiratory & Critical Care Medicine 1994;149(5):1359-74. (Bass, 1994, 1359)

G(Narr) T

A detailed document with no direct reference to CPR or the associated risks. Some value may be found by extrapolation in the section "Persons for whom preventive therapy is recommended." Mejicano (Mejicano, 1998, 813) uses this reference to support his statement "a rescuer who has given mouth-to-mouth ventilation to a patient with pulmonary tuberculosis should have serial tuberculin skin testing and should be offered prophylaxis if conversion occurs."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Becker LB, Berg RA, Pepe PE, Idris AH, Aufderheide TP, Barnes TA, et al. A reappraisal of mouth-to-mouth ventilation during bystander-initiated cardiopulmonary resuscitation. A statement for healthcare professionals from the Ventilation Working Group of the Basic Life Support and Pediatric Life Support Subcommittees, American Heart Association.[see comment]. Circulation 1997;96(6):2102-12. (Becker, 1997, 2102)

G(Narr) T

This review considers disease transmission within the question "Does mouth-to-mouth ventilation inhibit performance of bystander cardiopulmonary resuscitation?" It states "The actual risks of disease transmission during mouth-to-mouth ventilation are quite small," and refers to (Ahmad, 1990, 787) (Feldman, 1972, 1107) (Figura, 1996, Finkelhor, 1980, 650) (Heilman, 1965, 1035) (Hendricks, 1980, 257) (Mannis, 1984, 64) (Todd, 1980, 331) (Valenzuela, 1991, 90).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Berumen U. Dog poisons man. JAMA 1983; 249:253. (Berumen, 1983, 253)

NQS

An almost unique case; since animal resuscitation was not excluded in the evidence review, the case highlights the environmental risks of exposure.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Bierens JJ, Berden HJ. Basic-CPR and AIDS: are volunteer life-savers prepared for a storm? Resuscitation 1996; 32(3):185-91. (Bierens, 1996, 185)

GQT

Provides a rational approach to justify the statement that the risk of transmission of HIV is low i.e. "about one per million resuscitations in the highest risk group".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Blenkharn JI, Buckingham SE, Zideman DA. Prevention of transmission of infection during mouth-to-mouth resuscitation.[see comment]. Resuscitation 1990; 19(2):151-7. (Blenkharn, 1990, 151)

IT

An early assessment of the Resusci Face Shield (Laerdal Medical Limited).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Blenkharn JI, Zideman DA. Preventing transmission of infection during mouth-to-mouth resuscitation [comment]. Journal of Emergency Medicine 1992; 10(5):624-5. (Blenkharn, 1992, 624)

NQT

The author disputes one aspect of the findings of (Cydulka, 1991, 317)but remains supportive of the concept that a face shield will "satisfy the concern of the general public and of health care personnel relating to possible infection risks during exhaled air resuscitation and afford protection against the transmission of saliva, blood, and respiratory droplets during mouth-to-mouth ventilation." Refers to (Blenkharn, 1990, 151).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Bridgewater FHG.** What are the adverse effects for the responder who performs cardiopulmonary resuscitation (including infection control)? 2005 International Consensus on CPR and ECC Science with Treatment Recommendations Conference Circulation 2005; Volume 112(Issue 22 Supplement): November 29, 2005.

http://circ.ahajournals.org/content/vol0/issue2005/images/data/CIRCULATIONAHA.105.170522/DC235/W141C_Bridgewater.doc (accessed 2 February 2009) (Bridgewater, 2005)

G(Evb) JPQRST

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

***Bridgewater FHG.** What is the risk of infection or other adverse event during CPR training?

2005 International Consensus on CPR and ECC Science with Treatment Recommendations Conference (CoSTR) Circulation 2005; Volume 112(Issue 22 Supplements): November 29, 2005.

http://circ.ahajournals.org/content/vol0/issue2005/images/data/CIRCULATIONAHA.105.170522/DC336/W196_Bridgewater.doc (accessed 2February 2009) (Bridgewater, 2005)

G(Evb) JPQRST

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

***Cappato R, Curnis A, Marzollo P, Mascioli G, Bordonali T, Beretti S, et al.** Prospective assessment of integrating the existing emergency medical system with automated external defibrillators fully operated by volunteers and laypersons for out-of-hospital cardiac arrest: the Brescia Early Defibrillation Study (BEDS). Eur Heart J 2006; 27(5):553-61. (Cappato, 2006, 553)

HQRST

The trial does not contain a no treatment arm for either CPR/AED. The quality of evidence is deemed poor on the criterion of safety. There is no data supporting the claim.

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

***Capucci A, Aschieri D, Piepoli MF.** Improving survival with early defibrillation. *Cardiology Review* 2003; 20(8):12-14. (Capucci, 2003, 12)

HQRST

Provides minimal support for the claim of safety in the programme but does state “no adverse consequences from AED use by lay personnel were observed”. Again the quality is assessed on the criterion of demonstrated safety.

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

Cavagnolo RZ. Inactivation of herpes virus on CPR manikins utilizing a currently recommended disinfecting procedure. *Infection Control* 1985; 6(11):456-8. (Cavagnolo, 1985, 456)

IPT

Supportive of existing (1985) disinfection procedures for manikins.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Chalumeau M, Bidet P, Lina G, Mokhtari M, Andre M-C, Gendrel D, et al.** Transmission of Pantone-Valentine leukocidin-producing *Staphylococcus aureus* to a physician during resuscitation of a child. *Clin Infect Dis* 2005; 41(3):e29-30. (Chalumeau, 2005, e29)

HQT

Resuscitation involved intubation, BVM ventilation and chest compressions. Disease transmission confirmed but outcome for resuscitator not mentioned.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Cheung W, Gullick J, Thanakrishnan G, Jacobs R, Au W, Uy J, et al.** Injuries occurring in hospital staff attending medical emergency team (MET) calls-A prospective, observational study. (Cheung, 2009)

HQRS

States that it is the first study to document the actual rates of injuries occurring to staff responding to MET calls. It addresses the injuries associated with CPR and, in this setting, performance of chest compressions is a significant risk factor.

Level of Evidence: 4

Quality of Evidence: Good

Nature of Evidence: Neutral

Christian MD, Loutfy M, McDonald LC, Martinez KF, Ofner M, Wong T, et al. Possible SARS Coronavirus Transmission during Cardiopulmonary Resuscitation. *Emerging Infectious Diseases* 2004; 10(2):287-93. (Christian, 2004, 287)

HT

Only one of nine workers involved met WHO criteria for SARS. The principle espoused to generate policy change is the chance that a SARS patient will suffer unwitnessed cardiopulmonary arrest or require emergency intubation and resuscitation-associated risks must be minimised.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

Clements PAD. Hazards of performing chest compressions in collapsed patients with internal cardioverter defibrillators. *Emergency Medicine Journal* 2003; 20(4):379-80. (Clements, 2003, 379)

HQR

Three paramedics and one doctor performed external cardiac massage on an arrested patient with an internal cardioverter defibrillator (ICD). During the process the ICD discharged five times. The paramedic not wearing latex gloves when the ICD discharged received a shock and "had to rest for over half an hour before being able to resume work". Comparable with, and referred to by, (Siniorakis, 2009, 293)

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Neutral

Cohen HJ, Minkin W. Transmission of infection during training for cardiopulmonary resuscitation. *Annals of Internal Medicine* 1985; 102(1):136-7. (Cohen, 1985, 136)

NPT

The correspondents highlight the NRC 1984 Guidelines, express concern about transmission of viral diseases during training and the potential inadequacies of disinfection procedures, and advocate the use of an overlay mask.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Corless IB, Lisker A, Buckheit RW. Decontamination of an HIV-contaminated CPR manikin. *American Journal of Public Health* 1992; 82(11):1542-3. (Corless, 1992, 1542)

IPT

"Our data suggest that one should not refrain from CPR training out of fear of contracting HIV infection".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Cummins RD. Infection control guidelines for CPR providers. *JAMA* 1989; 262(19):2732-3. (Cummins, 1989, 2732)

GK

Editorial comment on [Anonymous, 1989 #7]. Notes that "CDC Cooperative Needlestick Surveillance Group has abandoned follow-up on health care workers exposed to saliva and other nonblood fluids from patients with HIV because none of 106 workers followed up for more than one year sero-converted." [McCray, 1986 #195] [Marcus, 1988 #194] and that a patient infected with HBV remains the greatest infectious threat to CPR providers. [Anonymous, 1989 #191] This should be considered with [Glaser, 1985 #146]

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Cutler SS. Safety of mouth-to-mouth resuscitation. Lancet 1979; 2(8151):1074. (Cutler, 1979, 1074)

NQ

Documents the 22 year record of the New York City Fire Department of no disease transmission through rescue breathing. No details of number resuscitated in this period. Response to (Davies, 1979, 593) and (Gilston, 1979, 694).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Cydulka RK, Connor PJ, Myers TF, Pavza G, Parker M. Prevention of oral bacterial flora transmission by using mouth-to-mask ventilation during CPR [see comment]. Journal of Emergency Medicine 1991; 9(5):317-21. (Cydulka, 1991, 317)

IQT

A technical assessment of ancillary equipment with one adverse finding being challenged by (Blenkharn, 1992, 624).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Davies JN. Operator risk in mouth-to-mouth resuscitation. Lancet 1979; 2(8142):593. (Davies, 1979, 593)

NQ

Raises the question of disease transmission and refers to (Osterholm, 1979, 1263)but makes no contribution to the worksheet hypothesis.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Davis GE. Promiscuous resuscitations--a public health problem? A plastic typhoid Mary. Journal of the Maine Medical Association 1978; 69(8):214. (Davis, 1978, 214)

G(Narr) PT

Cautionary concern about infectious disease transmission in the pre HIV/ AIDS era.

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral

Deetz TR. Operator risk in mouth-to-mouth resuscitation. Lancet 1979; 2(8148):912. (Deetz, 1979, 912)

NPT

Emphasizes the need for careful analysis of reported cases of disease transmission.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Dickinson CL, Hall CR, Soar J.** Accidental shock to rescuer during successful defibrillation of ventricular fibrillation – a case of human involuntary automaticity. Resuscitation 2008; 76(3):489. (Dickinson, 2008, 489)

HQR

Case report of staff member being shocked during defibrillation.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Dracup K, Moser DK, Taylor SE, Guzy PM. The psychological consequences of cardiopulmonary resuscitation training for family members of patients at risk for sudden death. *American Journal of Public Health* 1997; 87(9):1434-9. (Dracup, 1997, 1434)

HPS

The relevant component of this trial states "There were no significant differences in the emotional states of family members across the four groups."

Level of Evidence: 2

Quality of Evidence: Fair

Nature of Evidence: Supportive

Duffy P, Wolf J, Collins G, DeVoe AG, Streeten B, Cowen D. Letter: Possible person-to-person transmission of Creutzfeldt-Jakob disease. *New England Journal of Medicine* 1974; 290(12):692-3. (Duffy, 1974, 692)

HT

Relates to disease transmission by corneal transplantation.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Dunlap NE, Bailey WC, Bass JB, Jr., Boyd WW, Sutton FD, Tally WJ. Occupational exposure to tuberculosis: risk and consequences. *Chest* 1994; 106(3):658-9. (Dunlap, 1994, 658)

G(Narr)

Relates to occupational exposure to tuberculosis and the arguable need for the use of high efficiency particulate air (HEPA) respirators. No mention of CPR.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Edwards SM, Williams JC, McCahon RA. Universal precautions at cardiac arrests. *Anaesthesia* 2001; 56(4):378-79. (Edwards, 2001, 378)

L

Short article focuses on the provision of equipment for cardiac arrests and proposes that resuscitation is a high risk situation and that the anaesthetist is particularly at risk. It claims to identify a potential hazard where facilities are provided on a selective rather than universal approach.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Feldman HA. Some recollections of the meningococcal diseases. The first Harry F. Dowling lecture. *JAMA* 1972; 220(8):1107-12. (Feldman, 1972, 1107)

G(Narr)

Reports "at least four cases (of meningococcal disease) have followed mouth-to-mouth resuscitation".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Fenner P. Management of marine envenomation. Part 2: Other marine animals. *Modern Medicine of Australia* 1998; 41(2):90-95. (Fenner, 1998, 90)

M

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Figura N. Mouth-to-mouth resuscitation and helicobacter pylori infection [25]. *Lancet* 1996; 347(9011). (Figura, 1996)

HQT

Case report of possible transmission of Helicobacter pylori infection - Professional provided mouth-to-mouth resuscitation on patient who's "mouth was full of vomit". Actually a case of disease transmission, Professional-to-patient.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Finkelhor RS, Lampman JH. Herpes simplex infection following cardiopulmonary resuscitation. *JAMA* 1980; 243(7):650. (Finkelhor, 1980, 650)

QHT

Case report of resuscitator developing herpetic stomatitis and paronychia after performing CPR on a patient with mouth ulcers from which herpes simplex virus was isolated.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Gamble M. A debriefing approach to dealing with the stress of CPR attempts. *Professional Nurse* 2001; 17(3):157-60. (Gamble, 2001, 157)

G(Narr)QS

Suggests that CPR is highly stressful for the nursing staff and that this can be detrimental.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Genest M, Levine J, Ramsden V, et al. The impact of providing help: Emergency workers and cardiopulmonary resuscitation attempts. *Journal of Traumatic Stress* 1990; 3:305-09. (Genest, 1991)

HQS

It is notable that the study dealt with volunteer workers in unsuccessful attempts at CPR. Recognition of probable failure is not protective in itself. There was evidence of persisting psychological aftermaths with no respondent being entirely free from unbidden recollections of the experience.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

Genest M, Genest S, Swanson RW, et al. Emergency workers and CPR attempts. In: International Society for Traumatic Stress Studies; 1991; Washington, DC; 1991. (Genest, 1990, 305)

HQS

No conclusions can be made from this abstract. Attempt to pursue through University of Saskatchewan. burlock@duke.usask.ca Reply indicates authors cannot be traced.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Gibbs W, Eisenberg M, Damon SK.** Dangers of defibrillation: injuries to emergency personnel during patient resuscitation. *Am J Emerg Med* 1990;8(2):101-4.(Gibbs, 1990, 101)

LPQR

An early report of adverse events with AEDs. Data was generated from two sources: a retrospective questionnaire from local county personnel and reports from a national data base included in the questionnaire period. It is not clear whether some reports have been duplicated or not.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Gilston A. Operator risk in mouth-to-mouth resuscitation. *Lancet* 1979; 2(8144):694. (Gilston, 1979, 694)

NQ

Refers to (Heilman, 1965, 1035) and introduces the argument for ECM before EAR (in 1979!).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Glaser JB, Nadler JP. Hepatitis B virus in a cardiopulmonary resuscitation training course. Risk of transmission from a surface antigen-positive participant. *Archives of Internal Medicine* 1985; 145(9):1653-5. (Glaser, 1985, 1653)

HPT

This reinforces two other investigations suggesting that transmission under these circumstances is unlikely (Osterholm, 1979, 1263) (Anonymous, 1978, 247).

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Greenberg M. CPR: a report of observed medical complications during training. *Ann. Emerg. Med.* 1983; 12(3):194-5. (Greenberg, 1983, 194)

HNP

In response to (Memon, 1982, 322), four specific incidents are noted.

- *Left chest pain and SOB with preceding MI in a 48 yo male*
- *Recurrent mild anaphylaxis in a 28 yo female*
- *Chest pain with preceding angina in a 60 yo male*
- *Weakness, vertigo and altered mental state after 8 hr training course in a 25 yo female.*

He notes students have periodically complained of symptoms characteristic of hyperventilation.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al.** Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med* 2004; 351(7):637-46. (Hallstrom, 2004, 637)

HQRS

A detailed analysis of adverse effects is published separately as (Peberdy, 2006, 59). The report of AEs tallies to 8 and differentiates between AED and no AED but details are scant. Peberdy (Peberdy, 2006, 59) details seven but fails in not providing data to differentiate on the "AED versus no AED" question.

Level of Evidence: 1

Quality of Evidence: Fair

Nature of Evidence: Supportive

Handley AJ, Bahr J, Baskett P, Bossaert L, Chamberlain D, Dick W, et al. The 1998 European Resuscitation Council guidelines for adult single rescuer basic life support: A statement from the Working Group on Basic Life Support, and approved by the executive committee. [See comment][Erratum appears in *Resuscitation* 1998 Aug; 38(2):131-2]. *Resuscitation* 1998; 37(2):67-80. (Handley, 1998, 67)

J

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

***Handley AJ, Koster R, Monsieurs K, Perkins GD, Davies S, Bossaert L.** European Resuscitation Council guidelines for resuscitation 2005. Section 2. Adult basic life support and use of automated external defibrillators. *Resuscitation* 2005; 67 Suppl 1:S7-23. (Handley, 2005, S7)

JPQRST

Addresses "Risk to rescuer" with attention on disease transmission citing (Blenkharn, 1990, 151, Cydulka, 1991, 317, Heilman, 1965, 1035).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Heilman KM, Muschenheim C. Primary cutaneous tuberculosis resulting from mouth-to-mouth respiration. *New England Journal of Medicine* 1965; 273(19):1035-6. (Heilman, 1965, 1035)

HQT

Early advocate for ancillary devices in CPR to avoid the need for mouth-to-mouth resuscitation.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Hendricks AA, Shapiro EP. Primary herpes simplex infection following mouth-to-mouth resuscitation. *JAMA* 1980; 243(3):257-8. (Hendricks, 1980, 257)

HQT

Case report of disease transmission with reference to (Heilman, 1965, 1035). Advocates awareness of problem with use of protective devices and consideration of post-resuscitation testing for syphilis, hepatitis and tuberculosis.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Hodgin L. New law in the Big Apple mandates CPR infection-control equipment. Occupational Health & Safety 1992; 61(3):56, 58. (Hodgin, 1992, 56)

K

On the premise that trained personnel are reluctant to perform CPR because of fear of disease transmission, a city law was passed in January 2002 requiring all specified public places to have infection-control resuscitation equipment available.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

***Hoke RS, Heinroth K, Trappe HJ, Werdan K.** Is external defibrillation an electric threat for bystanders? Resuscitation 2009;80(4):395. (Hoke, 2009, 395)

GPQR

A recent systematic review of hazards for bystanders associated with the use of AEDs. The definition/use of "bystanders" needs clarification

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Hosmans TP, Maquoi I, Vogels C, Courtois AC, Micheels J, Lamy M, et al.** Safety of fully automatic external defibrillation by untrained lay rescuers in the presence of a bystander. Resuscitation 2008; 77(2):216-19. (Hosmans, 2008, 216)

IQR

A comparison of semi-automatic and fully automated defibrillators which highlights an unexpectedly high incidence of "unsafe behaviour" which it is argued may be an "overestimate". There is no control arm – two intervention arms (both AEDs) are compared. Hence its LOE.

Level of Evidence: 4

Quality of Evidence: Good

Nature of Evidence: Neutral or opposing

Industry Funding: Medtronic provided the training AEDs for use during the study period.

Hudson AD. A hypochlorite solution for removing bacteria from CPR manikins. Annals of Emergency Medicine 1983;12(8):485-8. (Hudson, 1983, 485)

IPT

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Hudson AD. Herpes simplex virus and CPR training manikins: reducing the risk of cross-infection. Annals of Emergency Medicine 1984;13(12):1108-10. (Hudson, 1984, 1108)

IPT

Demonstrates efficacy of standard cleaning technique with reference to (Todd, 1980, 331) (Deetz, 1979, 912) (Heilman, 1965, 1035) (Finkelhor, 1980, 650) (Hendricks, 1980, 257) (Achong, 1980, 759) (Davis, 1978, 214) (Khan, 1979, 2701) (Nicklin, 1980, 2046).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Ingram S, Maher V, Bennett K, Gormley J.** The effect of cardiopulmonary resuscitation training on psychological variables of cardiac rehabilitation patients. *Resuscitation* 2006; 71(1):89-96. (Ingram, 2006, 89)

HQS

A trial of teaching CPR to cardiac patients in a rehabilitation program citing (McLauchlan, 1992, 7) as the only other relevant data on the subject. Recognising the potential for an adverse cardiac event, precautionary warnings were given and relevant medications and an AED with a trained operator were immediately available. There is no record of any adverse event. It is not clear whether the AHA Family and Friends Basic Life Support course included AED usage.

<http://aha.channing-bete.com/family-friends/ff-cpr.html>

Level of Evidence: 2 (Level 5 for adverse physical events as conclusion is by inference from the data)

Quality of Evidence: Fair

Nature of Evidence: Supportive

Jacobson JA, Fraser DW. A simplified approach to meningococcal disease prophylaxis. *JAMA* 1976; 236(9):1053-4. (Jacobson, 1976, 1053)

MT

Considers mouth-to-mouth a risk factor for transmission of meningococcal disease and therefore an indicator for prophylaxis.

Level of Evidence: 5

Quality of Evidence: fair

Nature of Evidence: Neutral

Jevon P. Cardiopulmonary resuscitation. Mouth-to-mouth ventilation. *Nursing Times* 2002; 98(12):43-4. (Jevon, 2002, 43)

M

An educational short document making reference to (Mejicano, 1998, 813)]. Offers no new data.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

*** Jones AY.** Can cardiopulmonary resuscitation injure the back? (Jones, 2004, 63)

LQR

A retrospective questionnaire highlighting the frequency of back symptoms associated with performing CPR with adverse posturing among nurses.

Level of Evidence: 4

Quality of Evidence: fair

Nature of Evidence: Opposing

***Jones AY, Lee RY.** Cardiopulmonary resuscitation and back injury in ambulance officers. (Jones, 2005, 332)

LQR

The same hypothesis as Jones at al. above (Jones, 2004, 63) applied to ambulance officers with the same outcome. It emphasises the occupational hazards of certain professional groups.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: opposing

***Jorgenson DB, Skarr T, Russell JK, Snyder DE, Uhrbrock K.** AED use in businesses, public facilities and homes by minimally trained first responders. *Resuscitation* 2003; 59(2):225-33. (Jorgenson, 2003, 225)

HQS

A small trial with application of AED pads on thirteen occasions by "minimally trained first responders" and without reports of "injury or harm".

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

Industry Funding: Non declared

***Kerber RE.** "I'm clear, you're clear, everybody's clear": a tradition no longer necessary for defibrillation? *Circulation* 2008;117(19):2435-6. (Kerber, 2008, 2435)

O

An editorial comment on (Lloyd, 2008, 2510). The final paragraph states:

"The study by Lloyd et al. should lead the American Heart Association to consider a modification of the 2005 Guidelines:

Chest compressions may be safely continued through defibrillation provided that self-adhesive pad electrodes are used and gloves are worn.

Clinical experience will tell if injuries to patients or rescuers result when chest compression and defibrillation occur simultaneously; perhaps a registry of such injuries may be appropriate. The happy result of such a Guidelines change would be to advance the cause of achieving "effective" chest compressions during CPR: push hard, push fast, minimize interruptions."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Khan AH, Roland FP, Carleton RA. Cardiopulmonary resuscitation--potential danger of cross-infection. *JAMA* 1979; 241(25):2701-2. (Khan, 1979, 2701)

IPT

The deposition of normal oral bacteria onto manikin surfaces during training was seen as indicative of potential disease transmission. Swapping roles for two-person CPR training was seen as particularly hazardous.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Koksal N, Buyukbese MA, Guven A, Cetinkaya A, Hasanoglu HC.** Organophosphate intoxication as a consequence of mouth-to-mouth breathing from an affected case. *Chest* 2002; 122(2):740-1. (Koksal, 2002, 740)

HQR

It is noted that cholinesterase activity was not assayed in the two rescuers. While being treated as an OP poisoning, this has not been substantiated. How ever the potential can not be denied.

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral or opposing

Lambrew CT, Wynne N, Hume HA. Training mannequins an important source of transmission of hepatitis. Journal of the Maine Medical Association 1979; 70(1):44. (Lambrew, 1979, 44)

NPT

An editorial reflecting (Davis, 1978, 214)and referring to (Anonymous, 1978, 247).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Laws T. Examining critical care nurses' critical incident stress after in hospital cardiopulmonary resuscitation (CPR). Australian Critical Care 2001; 14(2):76-81. (Laws, 2001, 76)

HQS

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

* **Lechleuthner A.** Electric shock to paramedic during cardiopulmonary resuscitation of patient with implanted cardiodefibrillator. Lancet 1995;345:253. (Lechleuthner, 1995, 253)

HQR

Proably first case report of shock to rescuer from implanted defibrillator Subsequently reported by Clements (Clements, 2003, 379) and Siniorkakis (Siniorkakis, 2009, 293)

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Lloyd MS, Heeke B, Walter PF, Langberg JJ.** Hands-on defibrillation: An analysis of electrical current flow through rescuers in direct contact with patients during biphasic external defibrillation. Circulation 2008; 117(19):2510-14. (Lloyd, 2008, 2510)

HQS

This trial challenges the longstanding dogma of a mandatory "Stand Clear" by attending staff during defibrillation. If such a requirement was not necessary, significant interruption to the cardiac compressions would be avoided.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Industry Funding: This study was funded with discretionary accounts of the Clinical Electrophysiology Research Program

Loneragan JH, Youngberg JZ, Kaplan JA. Cardiopulmonary resuscitation: physical stress on the rescuer. Critical Care Medicine 1981; 9(11):793-5. (Loneragan, 1981, 793)

IR

This is interesting in relationship to the question of teaching CPR to rehabilitating cardiac patients (Ingram, 2006, 89) (McLauchlan, 1992, 7)

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Lufkin KC, Ruiz E. Mouth-to-mouth ventilation of cardiac arrested humans using a barrier mask. *Prehospital & Disaster Medicine* 1993; 8(4):333-5. (Lufkin, 1993, 333)

IT

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Lyster T, Jorgenson D, Morgan C. The safe use of automated external defibrillators in a wet environment. *Prehospital Emergency Care* 2003; 7(3):307-11. (Lyster, 2003, 307)

IQR

Australian Resuscitation Council policy accepts defibrillation as an element of BLS (Handley, 1998, 67) describes BLS as not using other equipment but continues "The development of automated defibrillation (AED) has allowed minimally trained persons to extend their BLS skills."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Macauley CA, Todd CT.** Physical disability among cardiopulmonary resuscitation students. *Occup Health Nurs* 1978; 26(3):17-9. (Macauley, 1978, 17)

H PT

One trainee became tachypnoeic after CPR practice and then declared a history of ischaemic heart disease.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Mannis MJ, Wendel RT. Transmission of herpes simplex during cardiopulmonary resuscitation training. *Comprehensive Therapy* 1984; 10(12):15-7. (Mannis, 1984, 15)

NOT AVAILABLE AND NOT ASSESSED IN EVIDENCE

Mannis MJ, Wendel RT. Transmission of herpes simplex during CPR training. *Ann. Ophthalmol.* 1984; 16(1):64-6. (Mannis, 1984, 64)

HPT

A report of two cases of possible disease transmission from the same training setting. Not proven by any means.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

Marcus R. Surveillance of health care workers exposed to blood from patients infected with the human immunodeficiency virus. [See comment]. *N. Engl. J. Med.* 1988; 319(17):1118-23. (Marcus, 1988, 1118)

HT

A later report of the same project as (McCray, 1986, 1127). Sixty of 1201 workers were exposed to blood by mucous-membrane contact. There is no statement that CPR was involved – only "various other procedures" are mentioned.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

McCabe E. Code team hazards. *Nursing Management* 1997; 28(3):48K-48L. (McCabe, 1997, 48K)

G

Emphasises occupational health and safety aspects of resuscitation but specifically refers to electrical hazards of cardioversion. The comments on chemical and environmental hazards omit mention of the poisoned/contaminated casualty.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

McCray E. Occupational risk of the acquired immunodeficiency syndrome among health care workers. *New England Journal of Medicine* 1986; 314(17):1127-32. (McCray, 1986, 1127)

HT

A 1986 report of the same project as (Marcus, 1988, 1118).

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

***McDaniel CM, Berry VA, Haines DE, Dimarco JP.** Automatic external defibrillation of patients after myocardial infarction by family members: Practical aspects and psychological impact of training. *PACE - Pacing and Clinical Electrophysiology* 1988; 11(11 II):2029-34. (McDaniel, 1988, 2029)

HPS

This trial reports the training of family members of cardiac patients in CPR and AED usage in 1988. This compares with teaching full basic life support (No AED) to both patients and family members by (McLauchlan, 1992, 7) and teaching CPR (? No AED) to cardiac patients and relatives by (Ingram, 2006, 89)

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

McLauchlan CAJ, Ward A, Murphy NM, Griffith MJ, Skinner DV, Camm AJ. Resuscitation training for cardiac patients and their relatives. Its effect on anxiety. *Resuscitation* 1992; 24(1):7-11. (McLauchlan, 1992, 7)

HPS

This trial, associated with the training of cardiac patients and relatives in full basic life support (No AED), is cited by (Ingram, 2006, 89). (McDaniel, 1988, 2029) taught relatives CPR and AED usage.

Level of Evidence: 3

Quality of evidence: Fair

Nature of Evidence: Supportive

Mejicano GC, Maki DG. Infections acquired during cardiopulmonary resuscitation: estimating the risk and defining strategies for prevention. *Annals of Internal Medicine* 1998; 129(10):813-28. (Mejicano, 1998, 813)

G(Evb) T

The conclusion may well be the proposal for this worksheet!

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

Memon AM, Salzer JE, Hillman EC, Jr., Marshall CL. Fatal myocardial infarct following CPR training: the question of risk. *Annals of Emergency Medicine* 1982;11(6):322-3. (Memon, 1982, 322)

HPR

Single case report of fatal myocardial infarction occurring during CPR training. Advocates that any persons with known ischaemic heart disease should be excluded from CPR training and that persons with risk factors for IHD should be assessed by a physician before CPR training.

Revealed (Macauley, 1978, 17) .

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral

***Messmer P, Meehan R, Gilliam N, White S, Donaldson P.** Teaching infant CPR to mothers of cocaine-positive infants. *J Contin Educ Nurs* 1993; 24(5):217-20. (Messmer, 1993, 217)

HPS

The unexpected positive effect on the mother of CPR training is a subjective reporting by the investigators of observed behavioural change consequent to the project. There was no intent to observe this in the study protocol.

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

Miller LV, Brennan R. Cardiac defibrillator use in potentially hazardous situations. *Biomedical Sciences Instrumentation* 1982; 18(pp 87-90). (Miller, 1982)

LPR

Assuming defibrillation is part of BLS and CPR this paper is acceptable.

Sixty American Emergency Medical Services were surveyed by questionnaire. One hundred and twenty responses were obtained from 42 organisations. Thirteen reported one or more incidents of minor shocks to rescuers, a bystander and a helicopter pilot due to moisture, conductive structures or confining locations.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Montgomery WH. The 1985 Conference on Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. *JAMA* 1986; 255(21):2990-1. (Montgomery, 1986, 2990)

O

Editorial referring to [Anonymous, 1986 #193]

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Moser DK, Dracup K.** Impact of cardiopulmonary resuscitation training on perceived control in spouses of recovering cardiac patients. *Res Nurs Health* 2000; 23(4):270-8. (Moser, 2000, 270)

HPS

Level of Evidence: 2

Quality of evidence: Fair

Nature of Evidence: Supportive

Moser DK, Dracup K, Doering LV. Effect of cardiopulmonary resuscitation training for parents of high- risk neonates on perceived anxiety, control, and burden. *Heart & Lung: Journal of Acute & Critical Care* 1999; 28(5):326-333. (Moser, 1999, 326)

PSH

Level of Evidence: 2

Quality of evidence: Fair

Nature of Evidence: Supportive

Neiman R. Post manikin resuscitation stomatitis. *Journal of the Kentucky Medical Association* 1982; 80(12):813-4. (Neiman, 1982, 813)

HPT

Case report of single case of aphthous ulceration after a basic CPR course with a prediction of "voluminous literature of morbidity to practitioners of CPR on manikins".

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral

***Nelson KM.** Cardiopulmonary resuscitation training for families of cardiac patients. *Cardiovasc Nurs* 1979; 15(6):28-32. (Nelson, 1979, 28)

G(Narr) PS

Concluding Paragraph:

CPR training for families of cardiac patients could seemingly produce various reactions. It is quite possible that anxiety would be increased by the unpleasantness of the subject. Unconscious fears would surface. The feeling of responsibility to save a human life and then coping with the guilt in the event of failure may be too overwhelming. Perhaps for these reasons CPR courses for families of cardiac patients have not been offered routinely by in-patient or out-patient educational and rehabilitative programs. Consideration should be given to the positive benefits of providing CPR training risk group, such as potent reducing mortality from sudden death. Anxiety' over e threat of sudden death could be mitigated by the acquisition of cognitive and technical skill. The ability to perform PR can serve as a valuable method of increasing the family's sense of control over unexpected, catastrophic events. For many people the guilt, frustration, and helplessness resulting from not knowing how to intervene when their loved one collapses could be far more overwhelming than if they tried and did not succeed. A patient may feel more secure knowing that his wife and/or children possess this skill.

An early publication on the potential psychological implications of training this group of people. No evidence provided.

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Supportive

Nickalls RW, Thomson CW. Mouth to mask respiration. *British Medical Journal Clinical Research Ed.* 1986; 292(6532):1350. (Nickalls, 1986, 1350)

NQT

Strongly supports use of ancillary airway devices.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Nicklin G. Manikin tracheitis. JAMA 1980; 244(18):2046-7. (Nicklin, 1980, 2046)

NPT

Personal account of symptoms developing after a CPR training session

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral

Ornato JP. Providing CPR and emergency care during the AIDS epidemic. Emerg. Med. Serv. 1989; 18(4):45-8. (Ornato, 1989, 45)

G(Narr) T

A statement of contemporaneous thought in 1989.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Osterholm MT, Bravo ER, Crosson JT, Polisky HF, Hanson M. Lack of transmission of viral hepatitis type B after oral exposure to HBsAg-positive saliva. British Medical Journal 1979; 2(6200):1263-4. (Osterholm, 1979, 1263)

HPT

Assesses 21 hospital trainees who had taken part in CPR training with a person with HBsAg-positive saliva. Circumstances were highly suited to disease transmission if it was possible. It did not occur. Mandatory testing of all individuals for HBsAg before CPR training is thought unwarranted.

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

***Page RL, Joglar JA, Kowal RC, Zagrodzky JD, Nelson LL, Ramaswamy K, et al.** Use of automated external defibrillators by a U.S. airline. N Engl J Med 2000; 343(17):1210-6. (Page, 2000, 1210)

HQ

Describes no adverse events with use of AEDs in first responder setting. Lacking data.

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

***Peberdy MA, Ottingham LV, Groh WJ, Hedges J, Terndrup TE, Pirrallo RG, et al.** Adverse events associated with lay emergency response programs: the public access defibrillation trial experience. Resuscitation 2006; 70(1):59-65. (Peberdy, 2006, 59)

HQRS

This is a critical report arising from data accumulated during the PAD trial (Hallstrom, 2004, 637). The emphasis is on the role of the AED and its relationship to adverse effects. It would be valuable to be able to separate AEs related to use/none use of the AED. This is not possible.

Level of Evidence: 4

Quality of Evidence: Poor

Nature of Evidence: Supportive

Industry Funding: Contract from National Heart, Lung and Blood Institute; and American Heart Association, Medtronic Incorporated, Guidant Foundation, Cardiac Science/Survivalink Inc, Philips Medical Systems and Laerdal Medical Corporation.

***Perkins GD, Lockey AS.** Defibrillation-Safety versus efficacy. Resuscitation 2008;79(1):1. (Perkins, 2008, 1)

OQRST

This editorial discusses the possibility of enhancing the efficacy of CPR without increasing the risks to those performing CPR. It favours a strategy that reduces the duration of the pre-shock pause. It anticipates the possibility of compressions during shocking as foreshadowed by Lloyd et al. (Lloyd, 2008, 2510)

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Author is supported by a Department of Health (UK) NIHR Clinician Scientist grant.

Perras ST, Poupard JA, Byrne EB, Nast PR. Lack of transmission of hepatitis non-A, non-B by CPR manikins. New England Journal of Medicine 1980;302(2):118-9. (Perras, 1980, 118)

NOT AVAILABLE AND NOT ASSESSED IN EVIDENCE

Prosser RL, Jr. Cardiopulmonary resuscitation training and risk of infection. JAMA 1990;263(22):3025. (Perras, 1980, 118, Prosser, 1990, 3025)

NPT

On the basis that there is risk, albeit minuscule, of contracting a serious infection during training the author proposes that "the requirement that mouth-mask-mannequin practice and testing be a part of basic and advanced cardiac life support courses should be eliminated".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Opposing

***Riegel B, Mosesso VN, Birnbaum A, Bosken L, Evans LM, Feeny D, et al.** Stress reactions and perceived difficulties of lay responders to a medical emergency. Resuscitation 2006; 70(1):98-106. (Riegel, 2006, 98)

HQS

Like (Peberdy, 2006, 59), these data have also arisen from the PAD trial (Hallstrom, 2004, 637). It is most significant in that it relates to the performance of CPR and the use of an AED in contrast to training for these tasks. There is no distinction on the matter of AED versus no AED. It shows the response to an emergency situation.

Level of Evidence: 4

Quality of Evidence: Good

Nature of Evidence: Supportive

Industry Funding: Contract from National Heart, Lung and Blood Institute; and American Heart Association, Medtronic Incorporated, Guidant Foundation, Cardiac Science/Survivalink Inc, Philips Medical Systems and Laerdal Medical Corporation.

Rinker AG, Jr. Disease transmission by mouth-to-mouth resuscitation. Emergency Medical Services 2001; 30(1):89-90. (Rinker, 2001, 89)

G(Narr)PQS

Adds no new information in texts or references

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Rossi R, Lindner KH, Ahnefeld FW. Devices for expired air resuscitation. *Prehospital & Disaster Medicine* 1993; 8(2):123-6. (Rossi, 1993, 123)

IT

Supportive of ancillary devices in airway management during CPR but mentions hazards of tubes.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

Salzer J, Marshall C, Hillman EJ, Bullock J. CPR: A report of observed medical complications during training. *Ann. Emerg. Med.* 1983; 12:195. (Salzer, 1983, 195)

NP

Subsequent to (Memon, 1982, 322) and (Greenberg, 1983, 194). All trainees who are asthmatic, diabetic, hypertensive, heavy smokers, obese, over the age of 45 or with pulmonary or cardiac disease are advised to have a medical assessment before undertaking the course.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Sande MA. Transmission of AIDS. The case against casual contagion. *N. Engl. J. Med.* 1986; 314(6):380-2. (Sande, 1986, 380)

OT

Maintains that the AIDS virus is transmitted sexually, by injection or by birth and that other modes are extremely rare. Mentions saliva but not CPR.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Saviteer SM, White GC, Cohen MS, Jason J. HTLV-III exposure during cardiopulmonary resuscitation. *New England Journal of Medicine* 1985; 313(25):1606-7. (Saviteer, 1985, 1606)

HNQT

A correspondence report of two nurses with documented mucous-membrane exposure to potentially infective saliva from a patient with AIDS-related complex without disease transmission providing "further evidence that the risk of seroconversion after a point exposure to the oral secretions of an infected person is probably quite low.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Schratter A, Weihs W, Holzer M, Janata A, Behringer W, Losert UM, et al.** External cardiac defibrillation during wet-surface cooling in pigs. *Am J Emerg Med* 2007; 25(4):420-4. (Schratter, 2007, 420)

IQR

The acceptance of resuscitative mild hypothermia as a therapeutic ploy raised the question of the safety of defibrillation in a wet environment. The simulated study of (Lyster, 2003, 307) provided evidence that a wet environment did not create a significant risk associated with defibrillation. This study, in a laboratory setting, looks at the situation when a wet environment is allied with a device

used to induce mild hypothermia. The conclusion is similar to that of (Lyster, 2003, 307). The work of (Lloyd, 2008, 2510) is also relevant.

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Supportive

Industry Funding: None declared.

Sepkowitz KA. Occupationally acquired infections in health care workers. Part II. [Erratum appears in Ann Intern Med 1997 Apr 1; 126(7):588]. Annals of Internal Medicine 1996; 125(11):917-28. (Sepkowitz, 1996, 917)

G(Evb) T

Excluding the item of blood-borne transmission, it is noted that there is no mention of disease transmission associated with CPR in the sections on Oral-Faecal Transmission or Direct Contact (pages 920-922).

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Sepkowitz KA. Occupationally acquired infections in health care workers. Part I. Annals of Internal Medicine 1996;125(10):826-34. (Sepkowitz, 1996, 826)

G(Evb) T

An extensive review, as required by the OBJECTIVE, fails to produce any reference to disease transmission during CPR.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Supportive

Shimokawa A, Tateyama S, Shimizu Y, Muramatsu I, Takasaki M. Anterior interosseous nerve palsy after cardiopulmonary resuscitation in a resuscitator with undiagnosed muscle anomaly. Anesthesia & Analgesia 2001;93(2):290-1. (Shimokawa, 2001, 290)

HQR

The palsy developed after 30 minutes of CPR. Spontaneous recovery did not occur. Exploration was necessary to determine the cause and provide relief.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Sigsbee M, Geden EA.** Effects of anxiety on family members of patients with cardiac disease learning cardiopulmonary resuscitation. Heart Lung 1990;19(6):662-5. (Sigsbee, 1990, 662)

HPS

Benefit was confirmed for only one arm of the trial i.e. Family members of hospitalized patients.

Level of Evidence: 2

Quality of Evidence: Fair

Nature of Evidence: Supportive

Simmons M, Deao D, Moon L, Peters K, Cavanaugh S. Bench evaluation: three face-shield CPR barrier devices. Respiratory Care 1995;40(6):618-23. (Simmons, 1995, 618)

IT

Questions the efficacy of a selection of particular face-shields in CPR.

NOT RELEVANT AND NOT ASSESSED IN EVIDENCE

***Siniorakis E, Hardavella G, Arvanitakis S, Roulia G, Voutas P, Karidis C.** Accidental shock to rescuer from an implantable cardioverter defibrillator. *Resuscitation* 2009;80(3):293-4. (Siniorakis, 2009, 293)

HQR

Case report of rescuer (not wearing gloves) being shocked by an implantable cardioverter defibrillator. Minor physical injuries resulted. Comparable with (Clements, 2003, 379) . Proposal that resuscitation of such patients should be considered in guideline preparation

Level of Evidence: 5

Quality of evidence : Fair

Nature of Evidence: Neutral

Stacey R, Morfey D, Payne S. Secondary contamination in organophosphate poisoning: Analysis of an incident. *Qjm: Monthly Journal of the Association of Physicians* 2004;97(2):75-80. (Stacey, 2004, 75)

HQR

Strictly not CPR but the patient needed airway management and cardiac support with the associated risks of exposure of personnel to an organophosphate compound. (Koksal, 2002, 740) reports an OP poisoning with subsequent mouth-to-mouth resuscitation and the allied sequelae.

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

Steinhoff JP, Pattavina C, Renzi R. Puncture wound during CPR from sternotomy wires: case report and discussion of periresuscitation infection risks. *Heart & Lung: Journal of Acute & Critical Care* 2001;30(2):159-60. (Steinhoff, 2001, 159)

159-60.

HQT

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Stern A, Dickinson E. Don't be a dummy. Staying safe with mannequin training. *Journal of Emergency Medical Services* 1994;19(5):85-6. (Stern, 1994, 85)

M

Highlights issues about cross-contamination and the use of manikins

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Sullivan F, Avstreich D. Pneumothorax during CPR training: case report and review of the CPR literature. *Prehospital & Disaster Medicine* 2000; 15(1):64-9. (Sullivan, 2000, 64)

HPR

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

* **Sullivan JL.** Letter by Sullivan regarding article, "Hands-on defibrillation: an analysis of electrical current flow through rescuers in direct contact with patients during biphasic external defibrillation". *Circulation* 2008;118(23):e712; author reply e713. (Sullivan, 2008, e712; author reply e713)

NQR

A letter critical of Lloyd's paper (Lloyd, 2008, 2510) on scientific grounds and advocating a "no change" stance in guidelines. Lloyd responds in the same journal "...we and the remainder of clinicians should stick to the guidelines."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Sun D, Bennett RB, Archibald DW. Risk of acquiring AIDS from salivary exchange through cardiopulmonary resuscitation courses and mouth-to-mouth resuscitation. *Seminars in Dermatology* 1995; 14(3):205-11. (Sun, 1995, 205)

G(Narr) PT

Advocates teaching mouth-to-mouth ventilation performed with some form of barrier-device.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

Swanson RW. Psychological issues in CPR. *Annals of Emergency Medicine* 1993; 22(2 Pt 2):350-3. (Swanson, 1993, 350)

G(Narr) QS

Swanson refers to "serious consequences for emergency personnel who respond to a crisis" but accepts that "the paucity of data currently available prevents firm conclusions about the effects on emergency personnel and may not be relevant to more routine CPR attempts."

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Tarantola A, Abiteboul D, Rachline A.** Infection risks following accidental exposure to blood or body fluids in health care workers: a review of pathogens transmitted in published cases. *Am J Infect Control* 2006; 34(6):367-75. (Tarantola, 2006, 367)

G(Evb)T

This article highlights the potential risk of disease transmission to HCWs but most recorded events have involved needle stick injuries with only one involving CPR (Valenzuela, 1991, 90). It also notes that "No new case of occupational infection with HIV has been documented in France since 1997".

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Theodorou AA, Gutierrez JA, Berg RA.** Fire attributable to a defibrillation attempt in a neonate. *Pediatrics* 2003; 112(3 Pt 1):677-9. (Theodorou, 2003, 677)

HQR

Case report of clothing of neonate catching fire during defibrillation. Mentioned in (Anonymous, 2005, IV1) Part 5.

Level of Evidence: 5

Quality of Evidence: Good

Nature of Evidence: Neutral

Thierbach AR, Wolcke BB, Krummenauer F, Kunde M, Janig C, Dick WF. Artificial ventilation for basic life support leads to hyperventilation in first aid providers. *Resuscitation* 2003; 57(3):269-77. (Thierbach, 2003, 269)

IQR

Recognising this matter, guidelines published in 2005 (Anonymous, 2005, IV1) recommended lower tidal volumes (6 to 7 mL/kg) and "regular rather than a deep breath".

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

***Thierbach AR, Piepho T, Kunde M, Wolcke BB, Golecki N, Kleine-Weischede B, et al.** Two-rescuer CPR results in hyperventilation in the ventilating rescuer. *Resuscitation* 2005; 65(2):185-90. (Thierbach, 2005, 185)

IQR

Recognising this matter, guidelines published in 2005 (Anonymous, 2005, IV1) recommended lower tidal volumes (6 to 7 mL/kg) and "regular rather than a deep breath".

Level of Evidence: 4

Quality of Evidence: Fair

Nature of Evidence: Neutral

Industry Funding: None declared.

Todd MA, Bell JS. Shigellosis from cardiopulmonary resuscitation. *JAMA* 1980; 243(4):331. (Todd, 1980, 331)

HQT

The authors believe that the case confirms oral transmission of pathogenic bacteria during CPR in an emergency situation and refer to (Khan, 1979, 2701).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Valenzuela TD, Hooton TM, Kaplan EL, Schlievert P. Transmission of 'toxic strep' syndrome from an infected child to a firefighter during CPR. *Annals of Emergency Medicine* 1991; 20(1):90-2. (Valenzuela, 1991, 90)

HQT

The fire-fighter ventilated the child with a B-V-M apparatus but his hands became covered with the child's sputum. He later injured his right hand causing an abrasion.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Walker GM, Liddle R. Prolonged two-man basic life support may result in hypocarbia in the ventilating rescuer. *Resuscitation* 2001; 50(2):179-83. (Walker, 2001, 179)

IR

This was substantiated in the later work of (Thierbach, 2003, 269) and (Thierbach, 2005, 185).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Neutral

Wenzel V, Idris AH, Dorges V, Nolan JP, Parr MJ, Gabrielli A, et al. The respiratory system during resuscitation: A review of the history, risk of infection during assisted ventilation, respiratory mechanics, and ventilation strategies for patients with an unprotected airway. *Resuscitation* 2001;49(2):123-34. (Wenzel, 2001, 123)

G(Narr) T

In summary after considering mouth-to-mouth resuscitation and the fear of infectious diseases the conclusion is made that disease transmission (patient-to-professional) is more likely with tuberculosis than HIV and that "the benefit of basic life support for a patient in cardiopulmonary or respiratory arrest greatly outweighs the risk for secondary infection in the rescuer or the patient."

No unrecognised references or evidence are provided.

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

West K. CPR infection-control article unclear. *Occupational Health & Safety* 1990;59(12):28. (West, 1990, 28)

NT

The author is critical of a preceding article (Yeager, 1990, 51) and refers to (Glaser, 1985, 1653).

Level of Evidence: 5

Quality of Evidence: Fair

Nature of Evidence: Supportive

***Yeager M.** Concerns about contagious disease prompt infection controls for CPR. [See comment]. *Occupational Health & Safety* 1990; 59(7):51-2. (Yeager, 1990, 51)

OPQS

Level of Evidence: 5

Quality of Evidence: Poor

Nature of Evidence: Neutral

Bibliography

- Achong MR. Hazards of mouth-to-mouth resuscitation. *Lancet* 1979;2(8150):1025.
 Achong MR. Infectious hazards of mouth-to-mouth resuscitation. *American Heart Journal* 1980;100(5):759.
 Ahmad F, Senadhira DCA, Charters J, Acquilla S. Transmission of salmonella via mouth-to-mouth resuscitation. *Lancet* 1990;335(8692):787.
 Anonymous. Lack of transmission of hepatitis B after oral exposure to hepatitis B surface antigen-positive saliva. *MMWR - Morbidity & Mortality Weekly Report* 1978(27):247.
 Anonymous. Disinfection of C.P.R. training manikins. *Australian Nurses' Journal* 1979;8(10):14.
 Anonymous, editor. Guidelines for the prevention of disease transmission in the use of CPR. Washington DC: National Research Council; 1984.
 Anonymous. Standards and guidelines for Cardiopulmonary Resuscitation (CPR) and Emergency Cardiac Care (ECC). National Academy of Sciences - National Research Council.[erratum appears in *JAMA* 1986 Oct 3;256(13):1727]. *JAMA* 1986;255(21):2905.
 Anonymous. Recommendations for prevention of HIV transmission in health-care settings. *MMWR - Morbidity & Mortality Weekly Report* 1987;36 Suppl 2:1S.

Anonymous. Guidelines for prevention of transmission of human immunodeficiency virus and hepatitis B virus to health-care and public-safety workers.[erratum appears in MMWR Morb Mortal Wkly Rep 1989 Nov 3;38(43):746]. MMWR - Morbidity & Mortality Weekly Report 1989;38 Suppl 6:3.

Anonymous. Risk of infection during CPR training and rescue: supplemental guidelines. The Emergency Cardiac Care Committee of the American Heart Association. JAMA 1989;262(19):2714.

Anonymous. CDC issues guidelines for protection against viral hepatitis. Clinical Pharmacy 1990;9(9):670.

Anonymous. Disease transmission and cardiopulmonary resuscitation. Emergency Cardiac Care Committee, Heart and Stroke Foundation of Canada. CMAJ Canadian Medical Association Journal 1990;143(10):1007.

Anonymous. Protection against viral hepatitis. Recommendations of the Immunization Practices Advisory Committee (ACIP). Morbidity & Mortality Weekly Report. Recommendations & Reports 1990;39(RR-2):1.

Anonymous. Guidelines for cardiopulmonary resuscitation and emergency cardiac care, Emergency Cardiac Care Committee and Subcommittees, American Heart Association Part. II. Adult basic life support (See Comment). JAMA 1992;268:2195.

Anonymous. Q & A: disinfecting Resusci Annes. Healthcare Hazardous Materials Management 1992;5(9):11.

Anonymous. Control and prevention of meningococcal disease: recommendations of the Advisory Committee on Immunization Practices (ACIP). Morbidity & Mortality Weekly Report. Recommendations & Reports 1997;46(RR-5):1.

Anonymous. The 1998 European Resuscitation Council guidelines for adult single rescuer basic life support. Basic Life Support Working Group of the European Resuscitation Council.[see comment][erratum appears in BMJ 1998 Aug 22;317(7157):501]. BMJ 1998;316(7148):1870.

Anonymous. AHA clarifies message on mouth-to-mouth component of CPR. Arteriosclerosis, Thrombosis & Vascular Biology 1998;18(2):B3.

Anonymous. Guidelines 2000 for Cardiopulmonary resuscitation and emergency cardiovascular care - An international consensus on science. Resuscitation 2000;46(1-3):1.

Anonymous. Part 3: adult basic life support. European Resuscitation Council. Resuscitation 2000;46(1-3):29.

Anonymous. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation 2005;112(24 Suppl):IV1.

Anonymous. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Part 4: Adult Basic Life Support. Circulation 2005;112(24 Supplement):IV 19.

Anonymous. 2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Part 5: Electrical Therapies Automated External Defibrillators, Defibrillation, Cardioversion, and Pacing. Circulation 2005;112(24 Supplement):IV 35.

Arend CF. Transmission of infectious diseases through mouth-to-mouth ventilation: Evidence-based or emotion-based medicine? Arquivos Brasileiros de Cardiologia 2000;74(1):73.

Axelsson A, Herlitz J, Ekstrom L, Holmberg S. Bystander-initiated cardiopulmonary resuscitation out-of-hospital. A first description of the bystanders and their experiences. Resuscitation 1996;33(1):3.

Axelsson A, Herlitz J, Karlsson T, Lindqvist J, Graves JR, Ekstrom L, et al. Factors surrounding cardiopulmonary resuscitation influencing bystanders' psychological reactions. Resuscitation 1998;37(1):13.

Baker DJ. The pre-hospital management of injury following mass toxic release; a comparison of military and civil approaches. Resuscitation 1999;42(2):155.

Ballard JL, Musial MJ, Myers MG. Hazards of delivery room resuscitation using oral methods of endotracheal suctioning. Pediatric Infectious Disease 1986;5(2):198.

Baskett PJF. Ethics in cardiopulmonary resuscitation. Resuscitation 1993;25(1):1.

Bass JB, Jr., Farer LS, Hopewell PC, O'Brien R, Jacobs RF, Ruben F, et al. Treatment of tuberculosis and tuberculosis infection in adults and children. American Thoracic Society and The Centers for Disease Control and Prevention.[see comment]. American Journal of Respiratory & Critical Care Medicine 1994;149(5):1359.

Becker LB, Berg RA, Pepe PE, Idris AH, Aufderheide TP, Barnes TA, et al. A reappraisal of mouth-to-mouth ventilation during bystander-initiated cardiopulmonary resuscitation. A statement for healthcare professionals from the Ventilation Working Group of the Basic Life Support and Pediatric Life Support Subcommittees, American Heart Association.[see comment]. Circulation 1997;96(6):2102.

Berumen U. Dog poisons man. JAMA 1983;249:253.

Bierens JJ, Berden HJ. Basic-CPR and AIDS: are volunteer life-savers prepared for a storm? Resuscitation 1996;32(3):185.

Blenkharn JI, Buckingham SE, Zideman DA. Prevention of transmission of infection during mouth-to-mouth resuscitation.[see comment]. Resuscitation 1990;19(2):151.

Blenkharn JI, Zideman DA. Preventing transmission of infection during mouth-to-mouth resuscitation.[comment]. Journal of Emergency Medicine 1992;10(5):624.

Bridgewater FHG. What are the adverse effects for the responder who performs cardiopulmonary resuscitation (including infection control)?

. Circulation 2005;Volume 112(Issue 22 Supplement).

Bridgewater FHG. What is the risk of infection or other adverse event during CPR training?

. Circulation 2005;Volume 112(Issue 22 Supplement).

Cappato R, Curnis A, Marzollo P, Mascioli G, Bordonali T, Beretti S, et al. Prospective assessment of integrating the existing emergency medical system with automated external defibrillators fully operated by volunteers and laypersons for out-of-hospital cardiac arrest: the Brescia Early Defibrillation Study (BEDS). *Eur Heart J* 2006;27(5):553.

Capucci A, Aschieri D, Piepoli MF. Improving survival with early defibrillation. *Cardiology Review* 2003;20(8):12.

Cavagnolo RZ. Inactivation of herpesvirus on CPR manikins utilizing a currently recommended disinfecting procedure. *Infection Control* 1985;6(11):456.

Chalumeau M, Bidet P, Lina G, Mokhtari M, Andre M-C, Gendrel D, et al. Transmission of Panton-Valentine leukocidin-producing *Staphylococcus aureus* to a physician during resuscitation of a child. *Clin Infect Dis* 2005;41(3):e29.

Cheung W, Gullick J, Thanakrishnan G, Jacobs R, Au W, Uy J, et al. Injuries occurring in hospital staff attending medical emergency team (MET) calls-A prospective, observational study. *Resuscitation* 2009.

doi:10.1016/j.resuscitation.2009.09.010

Christian MD, Loufy M, McDonald LC, Martinez KF, Ofner M, Wong T, et al. Possible SARS Coronavirus Transmission during Cardiopulmonary Resuscitation. *Emerging Infectious Diseases* 2004;10(2):287.

Clements PAD. Hazards of performing chest compressions in collapsed patients with internal cardioverter defibrillators. *Emergency Medicine Journal* 2003;20(4):379.

Cohen HJ, Minkin W. Transmission of infection during training for cardiopulmonary resuscitation. *Annals of Internal Medicine* 1985;102(1):136.

Corless IB, Lisker A, Buckheit RW. Decontamination of an HIV-contaminated CPR manikin. *American Journal of Public Health* 1992;82(11):1542.

Cummins RD. Infection control guidelines for CPR providers. *JAMA* 1989;262(19):2732.

Cutler SS. Safety of mouth-to-mouth resuscitation. *Lancet* 1979;2(8151):1074.

Cydulka RK, Connor PJ, Myers TF, Pavza G, Parker M. Prevention of oral bacterial flora transmission by using mouth-to-mask ventilation during CPR.[see comment]. *Journal of Emergency Medicine* 1991;9(5):317.

Davies JN. Operator risk in mouth-to-mouth resuscitation. *Lancet* 1979;2(8142):593.

Davis GE. Promiscuous resuscitations--a public health problem? A plastic typhoid Mary. *Journal of the Maine Medical Association* 1978;69(8):214.

Deetz TR. Operator risk in mouth-to-mouth resuscitation. *Lancet* 1979;2(8148):912.

Dickinson CL, Hall CR, Soar J. Accidental shock to rescuer during successful defibrillation of ventricular fibrillation--a case of human involuntary automaticity. *Resuscitation* 2008;76(3):489.

Dracup K, Moser DK, Taylor SE, Guzy PM. The psychological consequences of cardiopulmonary resuscitation training for family members of patients at risk for sudden death. *American Journal of Public Health* 1997;87(9):1434.

Duffy P, Wolf J, Collins G, DeVoe AG, Streeten B, Cowen D. Letter: Possible person-to-person transmission of Creutzfeldt-Jakob disease. *New England Journal of Medicine* 1974;290(12):692.

Dunlap NE, Bailey WC, Bass JB, Jr., Boyd WW, Sutton FD, Tally WJ. Occupational exposure to tuberculosis: risk and consequences. *Chest* 1994;106(3):658.

Edwards SM, Williams JC, McCahon RA. Universal precautions at cardiac arrests. *Anaesthesia* 2001;56(4):378.

Feldman HA. Some recollections of the meningococcal diseases. The first Harry F. Dowling lecture. *JAMA* 1972;220(8):1107.

Fenner P. Management of marine envenomation. Part 2: Other marine animals. *Modern Medicine of Australia* 1998;41(2):90.

Figura N. Mouth-to-mouth resuscitation and helicobacter pylori infection [25]. *Lancet* 1996;347(9011).

Finkelhor RS, Lampman JH. Herpes simplex infection following cardiopulmonary resuscitation. *JAMA* 1980;243(7):650.

Gamble M. A debriefing approach to dealing with the stress of CPR attempts. *Professional Nurse* 2001;17(3):157.

Genest M, Genest S, Swanson RW, al. e. Emergency workers and CPR attempts. In: *International Society for Traumatic Stress Studies*; 1991; Washington, DC; 1991.

Genest M, Levine J, Ramsden V, al. e. The impact of providing help: Emergency workers and cardiopulmonary resuscitation attempts. *Journal of Traumatic Stress* 1990;3:305.

Gibbs W, Eisenberg M, Damon SK. Dangers of defibrillation: injuries to emergency personnel during patient resuscitation. *Am J Emerg Med* 1990;8(2):101.

Gilston A. Operator risk in mouth-to-mouth resuscitation. *Lancet* 1979;2(8144):694.

Glaser JB, Nadler JP. Hepatitis B virus in a cardiopulmonary resuscitation training course. Risk of transmission from a surface antigen-positive participant. *Archives of Internal Medicine* 1985;145(9):1653.

Greenberg M. CPR: a report of observed medical complications during training. *Annals of Emergency Medicine* 1983;12(3):194.

Hallstrom AP, Ornato JP, Weisfeldt M, Travers A, Christenson J, McBurnie MA, et al. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med* 2004;351(7):637.

Handley AJ, Bahr J, Baskett P, Bossaert L, Chamberlain D, Dick W, et al. The 1998 European Resuscitation Council guidelines for adult single rescuer basic life support: A statement from the Working Group on Basic Life Support, and approved by the executive committee.[see comment][erratum appears in Resuscitation 1998 Aug;38(2):131-2]. Resuscitation 1998;37(2):67.

Handley AJ, Koster R, Monsieurs K, Perkins GD, Davies S, Bossaert L. European Resuscitation Council guidelines for resuscitation 2005. Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 2005;67 Suppl 1:S7.

Heilman KM, Muschenheim C. Primary cutaneous tuberculosis resulting from mouth-to-mouth respiration. New England Journal of Medicine 1965;273(19):1035.

Hendricks AA, Shapiro EP. Primary herpes simplex infection following mouth-to-mouth resuscitation. JAMA 1980;243(3):257.

Hodgin L. New law in the Big Apple mandates CPR infection-control equipment. Occupational Health & Safety 1992;61(3):56.

Hoke RS, Heinroth K, Trappe HJ, Werdan K. Is external defibrillation an electric threat for bystanders? Resuscitation 2009;80(4):395.

Hosmans TP, Maquoi I, Vogels C, Courtois AC, Micheels J, Lamy M, et al. Safety of fully automatic external defibrillation by untrained lay rescuers in the presence of a bystander. Resuscitation 2008;77(2):216.

Hudson AD. A hypochlorite solution for removing bacteria from CPR manikins. Annals of Emergency Medicine 1983;12(8):485.

Hudson AD. Herpes simplex virus and CPR training manikins: reducing the risk of cross-infection. Annals of Emergency Medicine 1984;13(12):1108.

Ingram S, Maher V, Bennett K, Gormley J. The effect of cardiopulmonary resuscitation training on psychological variables of cardiac rehabilitation patients. Resuscitation 2006;71(1):89.

Jacobson JA, Fraser DW. A simplified approach to meningococcal disease prophylaxis. JAMA 1976;236(9):1053.

Jevon P. Cardiopulmonary resuscitation. Mouth-to-mouth ventilation. Nursing Times 2002;98(12):43.

Jones AY. Can cardiopulmonary resuscitation injure the back? Resuscitation 2004;61(1):63.

Jones AY, Lee RY. Cardiopulmonary resuscitation and back injury in ambulance officers. Int Arch Occup Environ Health 2005;78(4):332.

Jorgenson DB, Skarr T, Russell JK, Snyder DE, Uhrbrock K. AED use in businesses, public facilities and homes by minimally trained first responders. Resuscitation 2003;59(2):225.

Kerber RE. "I'm clear, you're clear, everybody's clear": a tradition no longer necessary for defibrillation? Circulation 2008;117(19):2435.

Khan AH, Roland FP, Carleton RA. Cardiopulmonary resuscitation--potential danger of cross-infection. JAMA 1979;241(25):2701.

Koksal N, Buyukbese MA, Guven A, Cetinkaya A, Hasanoglu HC. Organophosphate intoxication as a consequence of mouth-to-mouth breathing from an affected case. Chest 2002;122(2):740.

Lambrew CT, Wynne N, Hume HA. Training mannequins an important source of transmission of hepatitis. Journal of the Maine Medical Association 1979;70(1):44.

Laws T. Examining critical care nurses' critical incident stress after in hospital cardiopulmonary resuscitation (CPR). Australian Critical Care 2001;14(2):76.

Lechleuthner A. Electric shock to paramedic during cardiopulmonary resuscitation of patient with implanted cardiodefibrillator. Lancet 1995;345:253.

Lloyd MS, Heeke B, Walter PF, Langberg JJ. Hands-on defibrillation: An analysis of electrical current flow through rescuers in direct contact with patients during biphasic external defibrillation. Circulation 2008;117(19):2510.

Lonergan JH, Youngberg JZ, Kaplan JA. Cardiopulmonary resuscitation: physical stress on the rescuer. Critical Care Medicine 1981;9(11):793.

Lufkin KC, Ruiz E. Mouth-to-mouth ventilation of cardiac arrested humans using a barrier mask. Prehospital & Disaster Medicine 1993;8(4):333.

Lyster T, Jorgenson D, Morgan C. The safe use of automated external defibrillators in a wet environment. Prehosp Emerg Care 2003;7(3):307.

Macauley CA, Todd CT. Physical disability among cardiopulmonary resuscitation students. Occup Health Nurs 1978;26(3):17.

Mannis MJ, Wendel RT. Transmission of herpes simplex during cardiopulmonary resuscitation training. Comprehensive Therapy 1984;10(12):15.

Mannis MJ, Wendel RT. Transmission of herpes simplex during CPR training. Annals of Ophthalmology 1984;16(1):64.

Marcus R. Surveillance of health care workers exposed to blood from patients infected with the human immunodeficiency virus.[see comment]. New England Journal of Medicine 1988;319(17):1118.

McCabe E. Code team hazards. Nursing Management 1997;28(3):48K.

- McCray E. Occupational risk of the acquired immunodeficiency syndrome among health care workers. *New England Journal of Medicine* 1986;314(17):1127.
- McDaniel CM, Berry VA, Haines DE, Dimarco JP. Automatic external defibrillation of patients after myocardial infarction by family members: Practical aspects and psychological impact of training. *PACE - Pacing and Clinical Electrophysiology* 1988;11(11 II):2029.
- McLauchlan CAJ, Ward A, Murphy NM, Griffith MJ, Skinner DV, Camm AJ. Resuscitation training for cardiac patients and their relatives. Its effect on anxiety. *Resuscitation* 1992;24(1):7.
- Mejicano GC, Maki DG. Infections acquired during cardiopulmonary resuscitation: estimating the risk and defining strategies for prevention. *Annals of Internal Medicine* 1998;129(10):813.
- Memon AM, Salzer JE, Hillman EC, Jr., Marshall CL. Fatal myocardial infarct following CPR training: the question of risk. *Annals of Emergency Medicine* 1982;11(6):322.
- Messmer P, Meehan R, Gilliam N, White S, Donaldson P. Teaching infant CPR to mothers of cocaine-positive infants. *J Contin Educ Nurs* 1993;24(5):217.
- Miller LV, Brennan R. Cardiac defibrillator use in potentially hazardous situations. *Biomedical Sciences Instrumentation* 1982;18(pp 87-90).
- Montgomery WH. The 1985 Conference on Standards and Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. *JAMA* 1986;255(21):2990.
- Moser DK, Dracup K. Impact of cardiopulmonary resuscitation training on perceived control in spouses of recovering cardiac patients. *Res Nurs Health* 2000;23(4):270.
- Moser DK, Dracup K, Doering LV. Effect of cardiopulmonary resuscitation training for parents of high-risk neonates on perceived anxiety, control, and burden. *Heart & Lung: Journal of Acute & Critical Care* 1999;28(5):326.
- Neiman R. Post manikin resuscitation stomatitis. *Journal of the Kentucky Medical Association* 1982;80(12):813.
- Nelson KM. Cardiopulmonary resuscitation training for families of cardiac patients. *Cardiovasc Nurs* 1979;15(6):28.
- Nickalls RW, Thomson CW. Mouth to mask respiration. *British Medical Journal Clinical Research Ed.* 1986;292(6532):1350.
- Nicklin G. Manikin tracheitis. *JAMA* 1980;244(18):2046.
- Ornato JP. Providing CPR and emergency care during the AIDS epidemic. *Emergency Medical Services* 1989;18(4):45.
- Osterholm MT, Bravo ER, Crosson JT, Polisky HF, Hanson M. Lack of transmission of viral hepatitis type B after oral exposure to HBsAg-positive saliva. *British Medical Journal* 1979;2(6200):1263.
- Page RL, Joglar JA, Kowal RC, Zagrodzky JD, Nelson LL, Ramaswamy K, et al. Use of automated external defibrillators by a U.S. airline. *N Engl J Med* 2000;343(17):1210.
- Peberdy MA, Ottingham LV, Groh WJ, Hedges J, Terndrup TE, Pirrallo RG, et al. Adverse events associated with lay emergency response programs: the public access defibrillation trial experience. *Resuscitation* 2006;70(1):59.
- Perkins GD, Lockey AS. Defibrillation-Safety versus efficacy. *Resuscitation* 2008;79(1):1.
- Perras ST, Poupard JA, Byrne EB, Nast PR. Lack of transmission of hepatitis non-A, non-B by CPR manikins. *New England Journal of Medicine* 1980;302(2):118.
- Prosser RL, Jr. Cardiopulmonary resuscitation training and risk of infection. *JAMA* 1990;263(22):3025.
- Riegel B, Mosesso VN, Birnbaum A, Bosken L, Evans LM, Feeny D, et al. Stress reactions and perceived difficulties of lay responders to a medical emergency. *Resuscitation* 2006;70(1):98.
- Rinker AG, Jr. Disease transmission by mouth-to-mouth resuscitation. *Emergency Medical Services* 2001;30(1):89.
- Rossi R, Lindner KH, Ahnefeld FW. Devices for expired air resuscitation. *Prehospital & Disaster Medicine* 1993;8(2):123.
- Salzer J, Marshall C, Hillman EJ, Bullock J. CPR: A report of observed medical complications during training. *Annals of Emergency Medicine* 1983;12:195.
- Sande MA. Transmission of AIDS. The case against casual contagion. *New England Journal of Medicine* 1986;314(6):380.
- Saviteer SM, White GC, Cohen MS, Jason J. HTLV-III exposure during cardiopulmonary resuscitation. *New England Journal of Medicine* 1985;313(25):1606.
- Schratter A, Weihs W, Holzer M, Janata A, Behringer W, Losert UM, et al. External cardiac defibrillation during wet-surface cooling in pigs. *Am J Emerg Med* 2007;25(4):420.
- Sepkowitz KA. Occupationally acquired infections in health care workers. Part I. *Annals of Internal Medicine* 1996;125(10):826.
- Sepkowitz KA. Occupationally acquired infections in health care workers. Part II.[erratum appears in *Ann Intern Med* 1997 Apr 1;126(7):588]. *Annals of Internal Medicine* 1996;125(11):917.
- Shimokawa A, Tateyama S, Shimizu Y, Muramatsu I, Takasaki M. Anterior interosseous nerve palsy after cardiopulmonary resuscitation in a resuscitator with undiagnosed muscle anomaly. *Anesthesia & Analgesia* 2001;93(2):290.

Sigsbee M, Geden EA. Effects of anxiety on family members of patients with cardiac disease learning cardiopulmonary resuscitation. *Heart Lung* 1990;19(6):662.

Simmons M, Deao D, Moon L, Peters K, Cavanaugh S. Bench evaluation: three face-shield CPR barrier devices. *Respiratory Care* 1995;40(6):618.

Siniorakis E, Hardavella G, Arvanitakis S, Roulia G, Voutas P, Karidis C. Accidental shock to rescuer from an implantable cardioverter defibrillator. *Resuscitation* 2009;80(3):293.

Stacey R, Morfey D, Payne S. Secondary contamination in organophosphate poisoning: Analysis of an incident. *Qjm: Monthly Journal of the Association of Physicians* 2004;97(2):75.

Steinhoff JP, Pattavina C, Renzi R. Puncture wound during CPR from sternotomy wires: case report and discussion of periresuscitation infection risks. *Heart & Lung: Journal of Acute & Critical Care* 2001;30(2):159.

Stern A, Dickinson E. Don't be a dummy. Staying safe with mannequin training. *Journal of Emergency Medical Services* 1994;19(5):85.

Sullivan F, Avstreich D. Pneumothorax during CPR training: case report and review of the CPR literature. *Prehospital & Disaster Medicine* 2000;15(1):64.

Sullivan JL. Letter by Sullivan regarding article, "Hands-on defibrillation: an analysis of electrical current flow through rescuers in direct contact with patients during biphasic external defibrillation". *Circulation* 2008;118(23):e712; author reply e713.

Sun D, Bennett RB, Archibald DW. Risk of acquiring AIDS from salivary exchange through cardiopulmonary resuscitation courses and mouth-to-mouth resuscitation. *Semin Dermatol* 1995;14(3):205.

Swanson RW. Psychological issues in CPR. *Annals of Emergency Medicine* 1993;22(2 Pt 2):350.

Tarantola A, Abiteboul D, Rachline A. Infection risks following accidental exposure to blood or body fluids in health care workers: a review of pathogens transmitted in published cases. *Am J Infect Control* 2006;34(6):367.

Theodorou AA, Gutierrez JA, Berg RA. Fire attributable to a defibrillation attempt in a neonate. *Pediatrics* 2003;112(3 Pt 1):677.

Thierbach AR, Piepho T, Kunde M, Wolcke BB, Golecki N, Kleine-Weischede B, et al. Two-rescuer CPR results in hyperventilation in the ventilating rescuer. *Resuscitation* 2005;65(2):185.

Thierbach AR, Wolcke BB, Krummenauer F, Kunde M, Janig C, Dick WF. Artificial ventilation for basic life support leads to hyperventilation in first aid providers. *Resuscitation* 2003;57(3):269.

Todd MA, Bell JS. Shigellosis from cardiopulmonary resuscitation. *JAMA* 1980;243(4):331.

Valenzuela TD, Hooton TM, Kaplan EL, Schlievert P. Transmission of 'toxic strep' syndrome from an infected child to a firefighter during CPR. *Annals of Emergency Medicine* 1991;20(1):90.

Walker GM, Liddle R. Prolonged two-man basic life support may result in hypocarbia in the ventilating rescuer. *Resuscitation* 2001;50(2):179.

Wenzel V, Idris AH, Dorges V, Nolan JP, Parr MJ, Gabrielli A, et al. The respiratory system during resuscitation: A review of the history, risk of infection during assisted ventilation, respiratory mechanics, and ventilation strategies for patients with an unprotected airway. *Resuscitation* 2001;49(2):123.

West K. CPR infection-control article unclear. *Occupational Health & Safety* 1990;59(12):28.

Yeager M. Concerns about contagious disease prompt infection controls for CPR.[see comment]. *Occupational Health & Safety* 1990;59(7):51.