

## BIBLIOGRAPHY WOUND CARE

### What's the expected infection rate?

1. Buchanan JM et al: Postoperative infection in a casualty department. Br Med J 2:1678, 1961  
35 of 348 returning patients had "pus" at first dressing change (10%)
2. Galvin JR, DeSimone D. Infection rate of simple suturing. JACEP 1976 May;5(5):332-3. PMID: 775154  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=775154&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=775154&dopt=Abstract)  
16 of 332 returning for suture removal had inflammation +/- pus (4.8%)
3. Gosnold JK. Infection rate of sutured wounds. Practitioner. 1977 Apr;218(1306):584-5. PMID: 859805  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=859805&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=859805&dopt=Abstract).  
28 of 574 returned forms (1000 sent out) with infection (4.9%)
4. Rutherford WH, Spence RA. Infection in wounds sutured in the accident and emergency department. Ann Emerg Med. 1980 Jul;9(7):350-2. PMID: 6994527  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6994527&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6994527&dopt=Abstract)  
485 patients, 12 (2.47%) with "severe" infection, 22 (4.53%) with "mild infection" (7.0% total)
5. Hollander JE, Singer AJ, Valentine SM, Shofer FS. Risk factors for infection in patients with traumatic lacerations. Acad Emerg Med. 2001 Jul;8(7):716-20. PMID: 11435186  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=11435186&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11435186&dopt=Abstract)  
Structured closed-question data sheets were prospectively completed at the time of laceration repair and suture removal. Infection was determined at the time of suture removal. Multivariate modeling was used to determine the adjusted odds ratio (OR) of infection. Five thousand five hundred twenty-one patients were enrolled; 195 patients developed an infection (3.5%). An increased likelihood of wound infection was associated with age (adjusted OR per year, 1.01; 95% CI = 1.0 to 1.02); history of diabetes mellitus (adjusted OR 6.7; 95% CI = 1.7 to 26.4); laceration width (adjusted OR 1.05 per mm; 95% CI = 1.02 to 1.08); and presence of foreign body (adjusted OR 2.6; 95% CI = 1.3 to 5.2). Laceration location on the head/neck was associated with a decreased risk of infection (adjusted OR 0.28; 95% CI = 0.18 to 0.45).

### What is the "golden period" of suturing?

1. Roberts AH, Teddy PJ. A prospective trial of prophylactic antibiotics in hand lacerations. Br J Surg. 1977 Jun;64(6):394-6. PMID: 326330  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=326330&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=326330&dopt=Abstract)  
368 patients with hand lacerations - no relationship between time of suturing and subsequent infection
2. Nylén S, Carlsson B. Time factor, infection frequency and quantitative microbiology in hand injuries: a prospective study. Scand J Plast Reconstr Surg. 1980;14(2):185-9. PMID: 7013022  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7013022&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7013022&dopt=Abstract)  
108 hand lacerations, sharp and crush - no correlation between incidence of infection and time of repair (up to 18 hours)
3. Berk WA, Osbourne DD, Taylor DD. Evaluation of the 'golden period' for wound repair: 204 cases from a Third World emergency department. Ann Emerg Med. 1988 May;17(5):496-500. PMID: 3364832  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3364832&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3364832&dopt=Abstract)  
<19 hrs - 92% satisfactory healing  
>19 hrs - 77% satisfactory healing
4. Berk WA, Welch RD, Bock BF. Controversial issues in clinical management of the simple wound. Ann Emerg Med. 1992 Jan;21(1):72-80. PMID: 1539894  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1539894&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1539894&dopt=Abstract)

## Tetanus

### Do people still get tetanus?

1. [No authors listed] Diphtheria, tetanus, and pertussis: recommendations for vaccine use and other preventive measures. Recommendations of the Immunization Practices Advisory committee (ACIP). MMWR Morb Mortal Wkly Rep. 1991 Aug 8;40(RR-10):1-28. PMID: 1865873  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1865873&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1865873&dopt=Abstract)
  - a. about 100 cases of tetanus annually in US
  - b. in 5 - 10% of cases, minor wound or chronic skin lesion
  - c. in 10 - 20% of cases, no wound identified
  - d. 2/3 cases in age >50
  - e. if booster given more frequently than advised, increased adverse reactions
  - f. worldwide mortality from tetanus - ~50%
2. [No authors listed] Tetanus immunization recommendations for persons less than seven years old. American College of Emergency Physicians. Ann Emerg Med. 1987 Oct;16(10):1181-3. PMID: 3662172  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3662172&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3662172&dopt=Abstract)
3. (No authors listed) Tetanus immunization recommendations for persons seven years of age and older. American College of Emergency Physicians. Ann Emerg Med. 1986 Sep;15(9):1111-2. PMID: 3740602  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3740602&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3740602&dopt=Abstract)
4. Leibman JB. Tetanus immunization. Ann Emerg Med. 1997 Jan;29(1):192-3. PMID: 8998111  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8998111&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8998111&dopt=Abstract)
5. Hsu SS, Groleau G. Tetanus in the emergency department: a current review. J Emerg Med. 2001 May;20(4):357-65. PMID: 11348815  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=11348815&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11348815&dopt=Abstract)

Despite the availability of effective immunization to prevent tetanus, there are still up to one million cases per year worldwide. Although the majority of tetanus cases occur in third world countries, there are still significant numbers of cases occurring in countries such as the United States, where preventive immunization is easily accessible. The Emergency Physician has the opportunity to contribute to the decline of the incidence of tetanus through knowledge of those at greatest risk for inadequate immunization and through providing proper wound care and immunization prophylaxis.
6. [No authors listed] Deferral of routine booster doses of tetanus and diphtheria toxoids for adolescents and adults. MMWR Morb Mortal Wkly Rep. 2001 May 25;50(20):418, 427. PMID: 11400958  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=11400958&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=11400958&dopt=Abstract)

A shortage of tetanus and diphtheria toxoids (Td) and tetanus toxoid (TT) in the United States has resulted because one of two manufacturers discontinued production of tetanus toxoid-containing products. Aventis Pasteur (Swiftwater, Pennsylvania) is the only major manufacturer of tetanus and Td in the United States. In response to the shortage, Aventis Pasteur has increased production of Td to meet national needs; however, because 11 months are required for vaccine production, the shortage is expected to last for the remainder of 2001.

### Isn't everyone already immune?

1. Ruben FL, Nagel J, Fireman P. Antitoxin responses in the elderly to tetanus-diphtheria (TD) immunization. Am J Epidemiol. 1978 Aug;108(2):145-9. PMID: 707475  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=707475&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=707475&dopt=Abstract)

Of 69 nursing home residents (in Pittsburgh), only 51% had protective antibody levels to tetanus, 59% to diphtheria.
2. Crossley K, Irvine P, Warren JB, Lee BK, Mead K. Tetanus and diphtheria immunity in urban Minnesota adults. JAMA. 1979 Nov 23;242(21):2298-300. PMID: 490826  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=490826&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=490826&dopt=Abstract)

Age	Males with adequate immunization	Females with adequate immunization
<40 years	94%	86%
40 - 60 years	87%	35%
>60 years	41%	29%

3. Mullooly JP. Tetanus immunization of adult members of an HMO. Am J Public Health. 1984 Aug;74(8):841-2. PMID: 6742280  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6742280&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6742280&dopt=Abstract)  
Kaiser Permanente patients compliance with routine immunization every 10 years fell off with age to 28% in patients >70 years old
4. Scher KS, Baldera A, Wheeler WE, Walker R, Jones CW. Inadequate tetanus protection among the rural elderly. South Med J. 1985 Feb;78(2):153-6. PMID: 3975709  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3975709&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3975709&dopt=Abstract)  
Inadequate immunization in 29% of elderly, rural patients
5. Pai S, Romanic BM, Deforest A, Walters DT. Tetanus immune status of adult patients in an urban family practice. J Fam Pract. 1986 Dec;23(6):582-3. PMID: 3537202  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3537202&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3537202&dopt=Abstract)  
In a Wilmington, Delaware, practice, 103 patients tested, 5% subtherapeutic, all women age 34 to 60
7. Stair TO, Lippe MA, Russell H, Feeley JC. Tetanus immunity in emergency department patients. Am J Emerg Med. 1989 Nov;7(6):563-6. PMID: 2679573  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2679573&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2679573&dopt=Abstract)  
278 patients aged 8 to 91, 27 (9.7%) had antitetanus antibody levels below 0.01 U/ml

	<0.01 U/mL	>0.01 U/mL	P-value
<b>Age, years</b>	65 +/- 21	36 +/- 18	<.000001
<b>Education, years</b>	9 +/- 4	11 +/- 2	<.001
<b>Female (%)</b>	85%	54%	<.005
<b>Non-US origin (%)</b>	25%	7%	<.1
<b>Non-white</b>	62%	71%	NS
<b>History military service (%)</b>	0%	12%	NS

7. Brand DA, Acampora D, Gottlieb LD, Glancy KE, Frazier WH. Adequacy of antitetanus prophylaxis in six hospital emergency rooms. N Engl J Med. 1983 Sep 15;309(11):636-40. PMID: 6888430  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6888430&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6888430&dopt=Abstract)  
6% of patients were "undertreated", 17% were "overtreated"
8. Giangrasso J, Smith RK. Misuse of tetanus immunoprophylaxis in wound care. Ann Emerg Med. 1985 Jun;14(6):573-9. PMID: 3994081  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3994081&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3994081&dopt=Abstract)  
Of 201 patient who would potentially need tetanus immunoprophylaxis,  
24 received Td or TIG when not indicated  
3 were underimmunized
9. Gergen PJ, McQuillan GM, Kiely M, Ezzati-Rice TM, Sutter RW, Virella G. A population-based serologic survey of immunity to tetanus in the United States. N Engl J Med. 1995 Mar 23;332(12):761-6. PMID: 7862178  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7862178&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7862178&dopt=Abstract)  
10,168 patients age 6 years or older with protective levels >0.15 IU/ml  
6 - 11 years - 87.7%                      >70 years - 27.8%  
male                      - 79.0%                      female                      - 62.4%  
white                      - 72.7%                      black                      - 68.1%                      Hispanic                      - 57.9%
10. Costa AJ, Gerson LW. Tetanus immunization status and predictors of immunity in older family practice outpatients. J Am Board Fam Pract. 1998 Jul-Aug;11(4):315-7. PMID: 9719354  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9719354&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9719354&dopt=Abstract)

### How does the booster work? How long does it take?

1. Simonsen O, Kjeldsen K, Heron I. Immunity against tetanus and effect of revaccination 25-30 years after primary vaccination. Lancet. 1984 Dec 1;2(8414):1240-2. PMID: 6150278  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6150278&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6150278&dopt=Abstract)  
Of 418 patients age 25 to 30, 11% had antibody levels <0.01 IU/ml. All given boosters and retested in 4 weeks were adequately protected.

2. Simonsen O, Klaerke M, Jensen JE, Kjeldsen K, Hau C, Heron I. Revaccination against tetanus 17 to 20 years after primary vaccination: kinetics of antibody response. *J Trauma*. 1987 Dec;27(12):1358-61. PMID: 3694727  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3694727&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3694727&dopt=Abstract)  
 24 patients whose last tetanus immunization was 17 to 20 years prior. One was unprotected, 15 were minimally protected. At 4 days after the booster, ALL had adequate antibody levels.  
 The incubation period for tetanus is usually 14 to 21 days, but severely contaminated wounds have been reported which cause tetanus in 1 or 2 days. Thus, the TIG does have selective use in the ED.

### Why do we use dT rather than tetanus toxoid?

1. Karzon DT, Edwards KM. Diphtheria outbreaks in immunized populations. *N Engl J Med*. 1988 Jan 7;318(1):41-3. PMID: 3336382  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3336382&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3336382&dopt=Abstract)  
 Despite inadequate immunization in a large portion of the population, outbreaks are rare. Perhaps since children are so well immunized, there is no reservoir for virulent forms, while nontoxicogenic strains exist in carriers.
2. Harnisch JP, Tronca E, Nolan CM, Turck M, Holmes KK. Diphtheria among alcoholic urban adults. A decade of experience in Seattle. *Ann Intern Med*. 1989 Jul 1;111(1):71-82. PMID: 2472081  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2472081&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2472081&dopt=Abstract)  
 Three outbreaks between 1972 and 1982. 86% of cases were cutaneous. The attack rate was 5 times higher in Native Americans, and complications were substantially higher in patients age 60 or higher.

### What reactions can be expected from tetanus shots?

1. Jacobs RL, Lowe RS, Lanier BQ. Adverse reactions to tetanus toxoid. *JAMA*. 1982 Jan 1;247(1):40-2. PMID: 7053439  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7053439&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7053439&dopt=Abstract)  
 Of 740 patients re-examined:  
     33% had local edema and tenderness  
     15% had fever  
     33% had an "anaphylactoid" reaction
2. Middaugh JP. Side effects of diphtheria-tetanus toxoid in adults. *Am J Public Health*. 1979 Mar;69(3):246-9. PMID: 420370  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=420370&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=420370&dopt=Abstract)  
 87,000 doses given in mass vaccination program by jet injector. 2000 postcards sent, 697 returned.  
     42.7% had sore arm  
     34.8% had swelling at injection site  
     24.2% had itching  
     00.7% had abscess or infection
3. Zaloga GP, Chernow B. Life-threatening anaphylactic reaction to tetanus toxoid. *Ann Allergy*. 1982 Aug;49(2):107-8. PMID: 7103147  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7103147&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7103147&dopt=Abstract)  
 Strictly case reports. This article tells of collapse and airway compromise with eventual recovery.  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed\\_pubmed&from\\_uid=7103147](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed_pubmed&from_uid=7103147)
4. Macko MB, Powell CE. Comparison of the morbidity of tetanus toxoid boosters with tetanus-diphtheria toxoid boosters. *Ann Emerg Med*. 1985 Jan;14(1):33-5. PMID: 3965001  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3965001&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3965001&dopt=Abstract)

Side Effects	Toxoid (n=93)	dT (n=100)	P-value
None	43%	21%	<.001
Pain	48%	75%	<.001
Mild pain	34%	48%	<.001
Severe pain	14%	27%	<.05
Redness	19%	25%	NS
Swelling	26%	30%	NS

Itching	13%	18%	NS
Fever	2%	7%	NS

## Wound inspection

### How can I find possible foreign bodies?

1. Pond GD, Lindsey D. Localization of cactus, glass and other foreign bodies in soft tissues. *Ariz Med.* 1977 Oct;34(10):700-2. PMID: 931666  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=931666&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=931666&dopt=Abstract)  
6 varieties of glass placed in roast beef - all showed up on standard x-ray
2. Tandberg D. Glass in the hand and foot. Will an X-ray film show it? *JAMA.* 1982 Oct 15;248(15):1872-4. PMID: 6126603  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6126603&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6126603&dopt=Abstract)  
66 types of glass embedded in a chicken leg. All was visible on x-ray, even as small as 0.5 mm.
3. DeLacey G et al: Penetrating injuries: How easy is it to see glass (and plastic) on radiographs? *Br J Radiol* 58:27, 1985  
Glass was always seen; plastic was poorly seen and needed CT or xerography to localize.
4. Gron P, Andersen K, Vraa A. Detection of glass foreign bodies by radiography. *Injury.* 1986 Nov;17(6):404-6. PMID: 3818073  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3818073&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3818073&dopt=Abstract)  
27 patients with glass foreign body removed, 26 were seen on x-ray
5. Gooding GA, Hardiman T, Summers M, Stess R, Graf P, Grunfeld C. Sonography of the hand and foot in foreign body detection. *J Ultrasound Med.* 1987 Aug;6(8):441-7. PMID: 3305979  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3305979&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3305979&dopt=Abstract)  
Only about 15% of wooden foreign bodies seen on standard x-ray. Sonography "more useful."
6. Bodne D, Quinn SF, Cochran CF. Imaging foreign glass and wooden bodies of the extremities with CT and MR. *J Comput Assist Tomogr.* 1988 Jul-Aug;12(4):608-11. PMID: 3392261  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3392261&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3392261&dopt=Abstract)  
Only 2 wood FB seen as signal void on MR (out of 4 case reports)
7. Torfing KF, Teisen HG, Skjodt T. Computed tomography, ultrasonography and plain radiography in the detection of foreign bodies in pork muscle tissue. *ROFO Fortschr Geb Rontgenstr Nuklearmed.* 1988 Jul;149(1):60-2. PMID: 2840712  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2840712&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2840712&dopt=Abstract)  
Ultrasound and CT good, even picking up wood. Plain x-rays missed a lot.
8. Ginsburg MJ, Ellis GL, Flom LL. Detection of soft-tissue foreign bodies by plain radiography, xerography, computed tomography, and ultrasonography. *Ann Emerg Med.* 1990 Jun;19(6):701-3. PMID: 2188542  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2188542&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2188542&dopt=Abstract)  
2mm fragments of wood, glass, and plastic between two strips of steak  
glass - visible to all methods  
wood - visible only with ultrasound  
plastic - visible only with ultrasound
9. Montano JB, Steele MT, Watson WA. Foreign body retention in glass-caused wounds. *Ann Emerg Med.* 1992 Nov;21(11):1360-3. PMID: 1416332  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1416332&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1416332&dopt=Abstract)  
438 patients with 578 wounds. Glass found by examination in 7%. Of 137 x-rays, 8% positive for glass.  
Patients who said "glass still there" right 15 of 41 times.  
Retained in head (p=.003) and foot (p<.0005) were "high risk"  
MVA and stepping on glass (p<.0005)  
puncture wound vs. laceration (p<.0005)
10. Avner JR, Baker MD. Lacerations involving glass. The role of routine roentgenograms. *Am J Dis Child.* 1992 May;146(5):600-2. PMID: 1621664  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1621664&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1621664&dopt=Abstract)  
226 children with lacerations due to glass. Ten had "obvious glass contamination."  
160 wounds with bottom of wound seen and no glass visualized - x-ray positive for glass in 11 (6.9%)  
56 wounds with bottom not seen clearly - x-ray positive for glass in 12 (21.4%)

- Anderson MA, Newmeyer WL 3rd, Kilgore ES Jr. Diagnosis and treatment of retained foreign bodies in the hand. *Am J Surg.* 1982 Jul;144(1):63-7. PMID: 7091533  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7091533&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7091533&dopt=Abstract)  
 200 consecutive patients with retained foreign bodies (wood, glass, metal most common).  
 Average time to removal - 7 months.  
 Pain - 97 Pain with mass - 97 Infection - 16 Digital nerve neuropraxia - 4  
 75 patients had seen another physician prior to definitive care.
- Reiner B, Siegel E, McLaurin T, Pomerantz S, Allman R, Hebel JR, Fritz S, Protopapas Z. Evaluation of soft-tissue foreign bodies: comparing conventional plain film radiography, computed radiography printed on film, and computed radiography displayed on a computer workstation. *AJR Am J Roentgenol.* 1996 Jul;167(1):141-4. PMID: 8659358  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8659358&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8659358&dopt=Abstract)
- Etc: [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed\\_pubmed&from\\_uid=8659358](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed_pubmed&from_uid=8659358)

## Local anesthetic

### What anesthetic should I use?

- Altman RS, Smith-Coggins R, Ampel LL. Local anesthetics. *Ann Emerg Med.* 1985 Dec;14(12):1209-17. PMID: 4061995  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=4061995&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4061995&dopt=Abstract)  
 A good review article of what's available for injectable anesthetics: action, proper dosages, potential risks, and treatment of reactions, pharmacokinetics, risks of using, and ways in which agents are used to treat the most common agents, with notes on the special aspects of each agent..
- Ernst AA, Marvez-Valls E, Nick TG, Wahle M. Comparison trial of four injectable anesthetics for laceration repair. *Acad Emerg Med.* 1996 Mar;3(3):228-33. PMID: 8673778  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8673778&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8673778&dopt=Abstract)  
 Buffered lidocaine with epinephrine and lidocaine with epinephrine were more effective anesthetics during suturing, according to both the physicians and the patients. There was a tendency toward less pain with infiltration in buffered solutions, compared with plain lidocaine with epinephrine, but the comparisons did not reach statistical significance. Diphenhydramine with epinephrine was more painful to inject than were buffered lidocaine with epinephrine and lidocaine with epinephrine, and was less effective anesthetically than the other three solutions.

Agent	Trade name	Type of anesthetic	Concentration (%)	Maximum safe dose (mg/kg)	Onset – minutes	Duration - hours
Procaine	Novocain	Ester	0.5 – 1.0	7	2 – 5	0.25 – 0.75
Procaine with epinephrine				9		0.5 – 1.5
Lidocaine	Xylocaine	Amide	0.5 – 2.0	4.5	2 – 5	1 – 2
Lidocaine with epinephrine				7		2 – 4
Bupivacaine	Marcaine	Amide	0.125 – 0.25	2	2 – 5	4 – 8
Bupivacaine with epinephrine				3		8 - 16
Levobupivacaine	Chirocaine	Amide				

### How do I make it hurt less?

- Christoph RA, Buchanan L, Begalla K, Schwartz S. Pain reduction in local anesthetic administration through pH buffering. *Ann Emerg Med.* 1988 Feb;17(2):117-20. PMID: 2827545  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2827545&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2827545&dopt=Abstract)  
 Buffered locals from pH 5.0 (standard) to the 7.0 to 7.4 range - “significant” pain reduction.  
 (1% lidocaine, 1% lidocaine with epinephrine, 1% mepivacaine)  
 And many more which look at buffering:  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed\\_pubmed&from\\_uid=2827545](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=PubMed&cmd=Display&dopt=pubmed_pubmed&from_uid=2827545)

2. Bartfield JM, Raccio-Robak N, Salluzzo RF. Does topical lidocaine attenuate the pain of infiltration of buffered lidocaine? Acad Emerg Med. 1995 Feb;2(2):104-8. PMID: 7621214  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7621214&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7621214&dopt=Abstract) No.
3. Mader TJ, Playe SJ, Garb JL. Reducing the pain of local anesthetic infiltration: warming and buffering have a synergistic effect. Ann Emerg Med. 1994 Mar;23(3):550-4. PMID: 8135432  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8135432&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8135432&dopt=Abstract)

	Mean pain score	95% confidence intervals	P-value
Room temperature	5.5	-4.8 – 15.8	.0001
Warmed	2.0	-11.1 – 15.1	.0028
Buffered	1.1	-7.6 – 9.8	.0005
Warmed and buffered	-25.1	-37.2 - -13.0	

4. Bartfield JM et al: The effects of warming and buffering on pain of infiltration of lidocaine. Acad Emerg Med 2:254, 1995  
Warming does not enhance buffering
5. Edlich RF, Rodeheaver GT, Morgan RF, Berman DE, Thacker JG. Principles of emergency wound management. Ann Emerg Med. 1988 Dec;17(12):1284-302. PMID: 3057946  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3057946&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3057946&dopt=Abstract)  
30 gauge needle hurts less than 27 gauge or 25 gauge, but bends more easily. For a block, use 25 or 27g. Rapid injection (<2 seconds) hurts more than slow injection (10 seconds)
6. Arndt KA, Burton C, Noe JM. Minimizing the pain of local anesthesia. Plast Reconstr Surg. 1983 Nov;72(5):676-9. PMID: 6622575  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6622575&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6622575&dopt=Abstract)  
Superficial injection hurt more, but was effective more quickly. Deep injection hurt less.
7. Kelly AM, Cohen M, Richards D. Minimizing the pain of local infiltration anesthesia for wounds by injection into the wound edges. J Emerg Med. 1994 Sep-Oct;12(5):593-5. PMID: 7989683  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7989683&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7989683&dopt=Abstract)

	Number of patients	Average pain score	Range of pain
<b>Into wound edge</b>	41	24 mm	0 – 54 mm
<b>Into skin around wound</b>	40	42 mm	0 –129 mm

8. Ellis GL, Owens A. The efficacy and acceptability of using a jet injector in performing digital blocks. Am J Emerg Med. 1993 Nov;11(6):648-50. PMID: 8240573  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8240573&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8240573&dopt=Abstract)  
Jet in one digital nerve vs. needle in other. Pain at injection: jet - 2 needle - 5.5 p<.0001
9. Bierman SF. Painless wound injection through use of a two-finger confusion technique. Am J Emerg Med. 1988 May;6(3):266-7. PMID: 3370105  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3370105&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3370105&dopt=Abstract)  
This is a great technique – I use it a lot, especially in the very nervous. Get the article, read, and practice – you’ll be amazed.
10. Robson AK, Bloom PA. Suturing of digital lacerations: digital block or local infiltration? Ann R Coll Surg Engl. 1990 Nov;72(6):360-1. PMID: 2241053  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2241053&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2241053&dopt=Abstract)  
Digital block less painful than local injection. (p < 0.01)
11. Bartfield JM, Ford DT, Homer PJ. Buffered versus plain lidocaine for digital nerve blocks. Ann Emerg Med. 1993 Feb;22(2):216-9. PMID: 8381259  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8381259&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8381259&dopt=Abstract)  
31 patients in randomized, double-blinded, prospective study. Buffered significantly less painful.
12. Mader TJ, Playe SJ. Reducing the pain of local anesthetic infiltration: results of a national clinical practice survey. Am J Emerg Med. 1998 Oct;16(6):617. PMID: 9786552  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9786552&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9786552&dopt=Abstract)
13. Bartfield JM, Sokaris SJ, Raccio-Robak N. Local anesthesia for lacerations: pain of infiltration inside vs outside the wound. Acad Emerg Med. 1998 Feb;5(2):100-4. PMID: 9492127  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9492127&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9492127&dopt=Abstract)

Median pain scores for all inside-the-wound injections (14 mm) were lower than those with intact skin injections (37 mm;  $p < 0.0001$ ). In group 1, 4 subjects reported the first injection within the wound hurt most, 23 thought the intact skin hurt most, and 5 found no difference. In group 2, 18 subjects reported the first injection through intact skin hurt most, 5 believed the second injection within the wound hurt most, and 8 found no difference,  $p < 0.0001$ .

### How long does a local anesthesia last?

- Todd K, Berk WA, Huang R. Effect of body locale and addition of epinephrine on the duration of action of a local anesthetic agent. *Ann Emerg Med.* 1992 Jun;21(6):723-6. PMID: 1590615  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1590615&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1590615&dopt=Abstract)  
 20 subjects had 1 ml buffered 1% lidocaine injected intradermally on forehead, hand, forearm, and calf, then same sites using lidocaine with epinephrine.

	Face	Hand	Arm	Calf
Plain lidocaine	1 hr	2.4 +/- 0.8 hr	2.1 +/- 0.7 hr	2.2 +/- 0.6 hr
Lidocaine with epinephrine	5.3 +/- 3.3 hr	5.8 +/- 2.1 hr	8.9 +/- 2.7 hr	8.5 +/- 4.5 hr

- Green D, Walter J, Heden R, Menacker L. The effects of local anesthetics containing epinephrine on digital blood perfusion. *J Am Podiatry Assoc.* 1979 Jul;69(7):397-409. PMID: 501026  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=501026&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=501026&dopt=Abstract)  
 Plain lidocaine and bupivacaine caused local vasodilation to 3 times baseline, but returned to normal in 24 hours. When epinephrine added, there was vasoconstriction (lidocaine by 50%, bupivacaine by 25%) followed by vasodilation. Conclusion: small amount of -caine with low concentration epinephrine in young adults (i.e. no PVD) is okay.
- Sylaidis P, Logan A. Digital blocks with adrenaline. An old dogma refuted. *J Hand Surg [Br].* 1998 Feb;23(1):17-9. PMID: 9571472  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9571472&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9571472&dopt=Abstract)

### What about the topicals?

- Bonadio WA. TAC: a review. *Pediatr Emerg Care.* 1989 Jun;5(2):128-30. PMID: 2664722  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2664722&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2664722&dopt=Abstract)  
 Review of 11 articles showing 64 to 95% efficacy. There were 4 case reports of seizure or death.
- Daya MR, Burton BT, Schleiss MR, DiLiberti JH. Recurrent seizures following mucosal application of TAC. *Ann Emerg Med.* 1988 Jun;17(6):646-8. PMID: 3132066  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3132066&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3132066&dopt=Abstract)  
 2 ml TAC to oral mucosa laceration - seizure lasting 20 minutes
- Hegenbarth MA, Altieri MF, Hawk WH, Greene A, Ochsenschlager DW, O'Donnell R. Comparison of topical tetracaine, adrenaline, and cocaine anesthesia with lidocaine infiltration for repair of lacerations in children. *Ann Emerg Med.* 1990 Jan;19(1):63-7. PMID: 2297157  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2297157&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2297157&dopt=Abstract)

Local anesthetic – location	Number of patients	Adequate anesthesia
TAC face or scalp	212	171 (80.7%)
Lidocaine face or scalp	157	136 (86.6%)
TAC extremity or trunk	44	19 (43.2%)
Lidocaine extremity or trunk	47	42 (89.4%)

- Dailey RH. Fatality secondary to misuse of TAC solution. *Ann Emerg Med.* 1988 Feb;17(2):159-60. PMID: 3337432  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3337432&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3337432&dopt=Abstract)  
 10 ml TAC used on lip laceration in 7 month-old girl - found dead in crib at home 3 hours later
- Wase RE Jr, Cardwell P. XAP--an alternative to cocaine for topical anesthesia. *Ann Emerg Med.* 1994 Jan;23(1):30. PMID: 8273954  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8273954&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8273954&dopt=Abstract)  
 15 ml 2% viscous lidocaine (Xylocaine)  
 7.5 ml 1:1000 epinephrine (Adrenaline)  
 7.5 ml 2% topical tetracaine (Pontocaine)

Maximum dose: 3 ml to age 3 years, 5 ml if older. Blanching after 20 minutes. 16% required supplemental anesthesia.

- Rosenberg CA et al: Tetracaine - Adrenaline - Cocaine (TAC) versus xylocaine - adrenaline - pontocaine (XAP): efficacy of two topical anesthetics. *Ann Emerg Med* 23:630, 1994 (abstract)  
No difference found between the two.
- Schilling CG, Bank DE, Borchert BA, Klatzko MD, Uden DL. Tetracaine, epinephrine (adrenalin), and cocaine (TAC) versus lidocaine, epinephrine, and tetracaine (LET) for anesthesia of lacerations in children. *Ann Emerg Med*. 1995 Feb;25(2):203-8. PMID: 7832348  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7832348&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7832348&dopt=Abstract)  
No statistical difference in adequacy of analgesia or duration.
- Ernst AA, Marvez-Valls E, Nick TG, Weiss SJ. LAT (lidocaine-adrenaline-tetracaine) versus TAC (tetracaine-adrenaline-cocaine) for topical anesthesia in face and scalp lacerations. *Am J Emerg Med*. 1995 Mar;13(2):151-4. PMID: 7893297  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7893297&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7893297&dopt=Abstract)  
95 patients in randomized, prospective, double-blind study. Pain with LAT less than TAC (p=.036)  
Cost: LAT - \$3 TAC - \$35

### Won't the topical anesthetics increase my infection rate?

- Barker W, Rodeheaver GT, Edgerton MT, Edlich RF. Damage to tissue defenses by a topical anesthetic agent. *Ann Emerg Med*. 1982 Jun;11(6):307-10. PMID: 7081792  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7081792&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7081792&dopt=Abstract)  
Guinea pigs with standardized lab incisions contaminated with  $10^4$  Staph aureus. After 5 minutes, a gauze with either TAC or NSS was applied. After another 5 minutes, the wounds were taped closed. The infection rate in the TAC group was slightly higher (p < .05).
- Martin JR, Doezema D, Tandberg D, Umland E. The effect of local anesthetics on bacterial proliferation: TAC versus lidocaine. *Ann Emerg Med*. 1990 Sep;19(9):987-90. PMID: 2393184  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2393184&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2393184&dopt=Abstract)  
48 standard lacerations on pigs injected with  $10^4$  Staph aureus. 50% received TAC, other 50% lidocaine, then wounds closed in identical manner. After 48 hours,  $\log_{10}$  bacteria:  
TAC = 6.818 lidocaine = 6.820 p = NS

### What if they're allergic to lidocaine?

- Swanson JG. Assessment of allergy to local anesthetic. *Ann Emerg Med*. 1983 May;12(5):316-8. PMID: 6625285  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6625285&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6625285&dopt=Abstract)
- Swanson JG. An answer for a questionable allergy to local anesthetics. *Ann Emerg Med*. 1988 May;17(5):554. PMID: 3364847  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3364847&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3364847&dopt=Abstract)
- Schatz M, Fung DL. Anaphylactic and anaphylactoid reactions due to anesthetic agents. *Clin Rev Allergy*. 1986 May;4(2):215-27. PMID: 3516361  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3516361&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3516361&dopt=Abstract)
- Gall H, Kaufmann R, Kalveram CM. Adverse reactions to local anesthetics: analysis of 197 cases. *J Allergy Clin Immunol*. 1996 Apr;97(4):933-7. PMID: 8655888  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8655888&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8655888&dopt=Abstract)
- Ernst AA, Marvez-Valls E, Mall G, Patterson J, Xie X, Weiss SJ. 1% lidocaine versus 0.5% diphenhydramine for local anesthesia in minor laceration repair. *Ann Emerg Med*. 1994 Jun;23(6):1328-32. PMID: 8198309  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8198309&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8198309&dopt=Abstract)

Options:

- omit anesthesia for small laceration
- apply ice to wound as local anesthetic
- inject NSS with 0.9% benzyl alcohol
- inject 1% Benadryl® solution (1cc – 50 mg – Benadryl + 4 cc NSS)
- use conscious sedation or nitrous oxide
- use preservation-free lidocaine from the cardiac cart; give test dose 0.1 cc, wait 30 minutes before injection

## Skin preparation

### Do gloves really decrease infection rates? Would a mask help?

1. Worrall GJ: Repairing skin lacerations: does sterile technique matter? *Can Fam Physician* 33:1185, 1987  
25 wounds repaired under "sterile" conditions – 22 follow-up, 4 had infection requiring antibiotic  
25 repaired "clean" (no gloves, drape, or mask, wound cleaned in tap water) – 24 follow-up, 1 needed antibiotic
2. Bodiwala GG, George TK. Surgical gloves during wound repair in the accident-and-emergency department. *Lancet*. 1982 Jul 10;2(8289):91-2. PMID: 6123821  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6123821&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6123821&dopt=Abstract)

Infection	Gloves	No gloves
None	167 (82.7%)	170 (82.5%)
Mild	27 (13.4%)	27 (13.1%)
Severe	8 (4.0%)	9 (4.4%)
<b>Total wounds repaired</b>	<b>202</b>	<b>206</b>
3. Cruse PJ. Rationale for surgical gloves questioned. *Hosp Infect Control*. 1978 Jul;5(7):114. PMID: 10308223  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=10308223&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10308223&dopt=Abstract)
4. Caliendo JE. Letter: Surgical masks during laceration repair. *JACEP*. 1976 Apr;5(4):278-9. PMID: 933407  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=933407&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=933407&dopt=Abstract)  
With mask - 1/47 infected  
Without mask - 0/42 infected
5. Edlich RF, London SD. Wound repair: from ritual practice to scientific discipline. *J Trauma*. 1996 Feb;40(2):326-9. PMID: 8637094  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8637094&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8637094&dopt=Abstract)

### Do I shave around the wound?

1. Seropian R, Reynolds BM. Wound infections after preoperative depilatory versus razor preparation. *Am J Surg*. 1971 Mar;121(3):251-4. PMID: 5546329  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=5546329&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=5546329&dopt=Abstract)  
406 clean surgical wounds  
3.1% infection rate if hair removed pre-op  
0.6% infection rate if no hair removal
2. Cruse PJ, Foord R. A five-year prospective study of 23,649 surgical wounds. *Arch Surg*. 1973 Aug;107(2):206-10. PMID: 4719566  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=4719566&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4719566&dopt=Abstract)  
2.3% infection rate if shaved  
0.9% infection rate if no hair removed
3. Alexander JW, Fischer JE, Boyajian M, Palmquist J, Morris MJ. The influence of hair-removal methods on wound infections. *Arch Surg*. 1983 Mar;118(3):347-52. PMID: 6824435  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6824435&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6824435&dopt=Abstract)  
1013 clean and contaminated lacerations  
10% infection rate if hair shaved  
3.2% infection rate if hair just clipped
4. Masterson TM, Rodeheaver GT, Morgan RF, Edlich RF. Bacteriologic evaluation of electric clippers for surgical hair removal. *Am J Surg*. 1984 Sep;148(3):301-2. PMID: 6383095  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6383095&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6383095&dopt=Abstract)  
Clipper blades are carriers of bacteria but can easily be sterilized
5. Howell JM, Morgan JA. Scalp laceration repair without prior hair removal. *Am J Emerg Med*. 1988 Jan;6(1):7-10. PMID: 3334801  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3334801&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3334801&dopt=Abstract)  
68 scalp lacerations sewn "as is", no shave or clip → no infection
6. Thur de Koos P, McComas B. Shaving versus skin depilatory cream for preoperative skin preparation. A prospective study of wound infection rates. *Am J Surg*. 1983 Mar;145(3):377-8.

PMID: 6837864

[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6837864&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6837864&dopt=Abstract)  
Shave vs. depilatory – no difference in infection rates.

### What is the best skin disinfectant?

1. Kaul AF, Jewett JF. Agents and techniques for disinfection of the skin. Surg Gynecol Obstet. 1981 May;152(5):677-85. PMID: 7013126  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7013126&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7013126&dopt=Abstract)  
“...neither the ideal agent nor protocol for...skin preparation has yet been devised.”  
Hexachlorophene - too many side effects  
Iodophors - inadequate residual activity  
Benzalkonium - harbors contaminants  
Chlorhexidine - adequate disinfection, low toxicity

### Debridement - the most important step

1. Haury B, Rodeheaver G, Vensko J, Edgerton MT, Edlich RF. Debridement: an essential component of traumatic wound care. Am J Surg. 1978 Feb;135(2):238-42. PMID: 626301  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=626301&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=626301&dopt=Abstract)  
Proven to remove tissue contaminated with bacteria and devitalized tissue
2. Dimick AR. Delayed wound closure: indications and techniques. Ann Emerg Med. 1988 Dec;17(12):1303-4. PMID: 3195787  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3195787&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3195787&dopt=Abstract)  
Contaminated wounds were left open 4 to 5 days until edema subsided and no infection seen, all debris and exudate removed, then wound closed → >90% success rate in contaminated wounds. The final scar looked the same as comparable noncontaminated wounds closed primarily.
3. Shepard GH. Wounds treated by the healing of delayed primary closure: a clinical study. Mil Med. 1981 Jul;146(7):473-5. PMID: 6792558  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6792558&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6792558&dopt=Abstract)
4. Hudspeth AS. Elimination of surgical wound infections by delayed primary closure. South Med J. 1973 Aug;66(8):934-6. PMID: 4578610  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=4578610&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=4578610&dopt=Abstract)

### Wound preparation

#### First, do no harm

#### Povidone-iodine

1. Gosnold JK. Prophylaxis of wound infection. Practitioner. 1979 Aug;223(1334):271-3. PMID: 388404  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=388404&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=388404&dopt=Abstract)  
242 wounds in ED, treated with povidone-iodine dry powder spray  
treated - 2.5% infection rate  
untreated - 9.8% infection (?!?!)
2. Mulliken JB, Healey NA, Glowacki J. Povidone-iodine and tensile strength of wounds in rats. J Trauma. 1980 Apr;20(4):323-4. PMID: 7365838  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7365838&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7365838&dopt=Abstract)  
Clean, incised dorsal wounds in rats were soaked in 1% povidone-iodine solution for 15 minutes; control wounds were soaked in lactated Ringer's solution before closure. Tensile strength measurements and histologic studies were conducted at 1, 2, and 6 weeks. 1% povidone-iodine solution did not decrease wound tensile strength
3. Roberts AH, Roberts FE, Hall RI, Thomas IH. A prospective trial of prophylactic povidone iodine in lacerations of the hand. J Hand Surg [Br]. 1985 Oct;10(3):370-4. PMID: 3908603  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3908603&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3908603&dopt=Abstract)

	195 with povidone-iodine powder	223 controls
Infections – not in hand	4.6%	5.3%
Infections – hand wounds	5.7%	10.4%

4. Morgan WJ. The effect of povidone-iodine (Betadine) aerosol spray on superficial wounds. Br J Clin Pract. 1979 Apr;33(4):109-10. PMID: 475952  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=475952&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=475952&dopt=Abstract)

povidone iodine dry powder used on 572 wounds in the ED  
 head & neck - no difference in infection rates  
 hand & forearm - statistically significant improvement

5. Lineaweaver W, Howard R, Soucy D, McMorris S, Freeman J, Crain C, Robertson J, Rumley T. Topical antimicrobial toxicity. Arch Surg. 1985 Mar;120(3):267-70. PMID: 3970664  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3970664&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3970664&dopt=Abstract)  
 Only at a concentration of 0.001% was povidone-iodine bactericidal but NOT cytotoxic: 1% povidone-iodine, 3% hydrogen peroxide, 0.5% sodium hypochlorite, and 0.25% acetic acid are unsuitable for use in wound care.
6. Oberg MS. Povidone-iodine solutions in traumatic wound preparation. Am J Emerg Med. 1987 Nov;5(6):553-5. PMID: 3311063  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3311063&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3311063&dopt=Abstract)  
 Summary article of multiple *in vivo* and *in vitro* studies of povidone-iodine solutions.  
 SUMMARY: if diluted to 1% or less, appears to be safe, but conflicting results as to efficacy.
7. Oberg MS, Lindsey D. Do not put hydrogen peroxide or povidone iodine into wounds! Am J Dis Child. 1987 Jan;141(1):27-8. PMID: 3788878  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3788878&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3788878&dopt=Abstract)
8. Mayer DA. "The perils of povidone-iodine use". Ostomy Wound Manage. 1994 Oct;40(8):6, 8. PMID: 7546102  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7546102&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7546102&dopt=Abstract)
9. Viljanto J. Disinfection of surgical wounds without inhibition of normal wound healing. Arch Surg. 1980 Mar;115(3):253-6. PMID: 7356379  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7356379&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7356379&dopt=Abstract)  
 Appendectomy wounds irrigated with povidone-iodine.  
 With a 5% solution, there was a 19% infection rate.  
 If not irrigated, there was an 8% infection rate.
10. Rodeheaver G, Bellamy W, Kody M, Spatafora G, Fitton L, Leyden K, Edlich R. Bactericidal activity and toxicity of iodine-containing solutions in wounds. Arch Surg. 1982 Feb;117(2):181-6. PMID: 7034678  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=7034678&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=7034678&dopt=Abstract)  
 Povidone-iodine surgical scrub used in wounds significantly **increased** the infection rate.  
 Povidone-iodine solution did not effect the infection rate for good or bad.
11. Morgan WJ. The effect of povidone-iodine (Betadine) aerosol spray on superficial wounds. Br J Clin Pract. 1979 Apr;33(4):109-10. PMID: 475952  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=475952&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=475952&dopt=Abstract)  
 166 treated, 6% infection rate.  
 154 untreated, 14% infection rate.
12. Gravett A, Sterner S, Clinton JE, Ruiz E. A trial of povidone-iodine in the prevention of infection in sutured lacerations. Ann Emerg Med. 1987 Feb;16(2):167-71. PMID: 3800090  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3800090&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3800090&dopt=Abstract)  
 1% povidone-iodine solution used to flush wounds.
 

	Treated (n=201)	Control (n=194)
Infection	5.4%	<b>15.4% (?)</b>
Pus	0.9%	6.0%
13. Lammers RL, Fourre M, Callaham ML, Boone T. Effect of povidone-iodine and saline soaking on bacterial counts in acute, traumatic, contaminated wounds. Ann Emerg Med. 1990 Jun;19(6):709-14. PMID: 2344090  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=2344090&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=2344090&dopt=Abstract)  
 soak in 1% povidone-iodine for 10 minutes → no change in bacteria count  
 soak in normal saline solution for 10 minutes → **increase** in total bacterial load

## Hydrogen peroxide

1. Lineaweaver W, McMorris S, Soucy D, Howard R. Cellular and bacterial toxicities of topical antimicrobials. Plast Reconstr Surg. 1985 Mar;75(3):394-6. PMID: 3975287  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3975287&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3975287&dopt=Abstract)

Cellular and bacterial toxicities of four commonly used topical antimicrobials (1% povidone-iodine, 3% hydrogen peroxide, 0.25% acetic acid, and 0.5% sodium hypochlorite) were assayed in vitro using cultures of human fibroblasts and Staphylococcus aureus. All agents tested at full strength killed 100 percent of exposed fibroblasts. Fibroblast toxicity exceeded bacterial toxicity with serial dilutions of hydrogen peroxide and acetic acid. Dilutions of povidone-iodine (1:1000) and sodium hypochlorite (1:100) were identified where no fibroblast toxicity occurred while full bactericidal activity persisted.

- Gruber RP, Vistnes L, Pardoe R. The effect of commonly used antiseptics on wound healing. *Plast Reconstr Surg.* 1975 Apr;55(4):472-6. PMID: 1090959  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1090959&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1090959&dopt=Abstract)

Days to healing for...	...split-thickness skin graft	...full-thickness skin graft
Acetic acid 0.25%	12.0 days	18.6 days
Povidone-iodine 10%	12.2 days	19.2 days
Hydrogen peroxide 3%	10.2 days	17.0 days (p<.05)
Normal saline solution	12.4 days	19.5 days

### PHisoHex®

- Custer J, Edlich RF, Prusak M, Madden J, Panek P, Wangenstein OH. Studies in the management of the contaminated wound. V. An assessment of the effectiveness of pHisoHex and Betadine surgical scrub solutions. *Am J Surg.* 1971 May;121(5):572-5. PMID: 5557767  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=5557767&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=5557767&dopt=Abstract)  
 Scrubbing wounds with pHisoHex increase infection rate
- Burks RI. Povidone-iodine solution in wound treatment. *Phys Ther.* 1998 Feb;78(2):212-8. PMID: 9474112  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9474112&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9474112&dopt=Abstract)

### Hibiclens®

- Bryant CA, Rodeheaver GT, Reem EM, Nichter LS, Kenney JG, Edlich RF. Search for a nontoxic surgical scrub solution for periorbital lacerations. *Ann Emerg Med.* 1984 May;13(5):317-21. PMID: 6711927  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6711927&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6711927&dopt=Abstract)  
 Hibiclens used in periorbital wounds of rabbit. If it went into the eye, caused severe corneal scarring.

### Irrigation - how much, how hard, how sterile?

- Gross A, Cutright DE, Bhaskar SN. Effectiveness of pulsating water jet lavage in treatment of contaminated crushed wounds. *Am J Surg.* 1972 Sep;124(3):373-7. PMID: 5056898  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=5056898&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=5056898&dopt=Abstract)  
 200 rats with contaminated crush wounds (Klebsiella, Pseudomonas, Proteus, Staph. aureus) cleaned either with 25 ml bulb syringe or a pulsatile jet at 70 psi (350 cc for both).  
 "...all bacteriologic scores from the fourth to the tenth postoperative day were **lower in the wounds cleaned by the pulsating jet.**"
- Rodeheaver GT, Pettry D, Thacker JG, Edgerton MT, Edlich RF. Wound cleansing by high pressure irrigation. *Surg Gynecol Obstet.* 1975 Sep;141(3):357-62. PMID: 808870  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=808870&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=808870&dopt=Abstract)  
 Soil-contaminated wounds in guinea pigs

Irrigation pressure (pounds per square inch)	Infection rate	P-value
1	100%	
5	67%	NS
10	21%	<.02
15	7%	<.002

- Stevenson TR, Thacker JG, Rodeheaver GT, Bacchetta C, Edgerton MT, Edlich RF. Cleansing the traumatic wound by high pressure syringe irrigation. *JACEP.* 1976 Jan;5(1):17-21. PMID: 933383  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=933383&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=933383&dopt=Abstract)  
 19 gauge needle with 35 ml syringe → 7 psi  
 19 gauge needle with 12 ml syringe → 20 psi

infection rate not significantly different

4. Brown LL, Shelton HT, Bornside GH, Cohn I Jr. Evaluation of wound irrigation by pulsatile jet and conventional methods. *Ann Surg.* 1978 Feb;187(2):170-3. PMID: 343735  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=343735&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=343735&dopt=Abstract)  
gravity vs. bulb syringe vs. pulsatile flow  
“...only pulse jet irrigation brought about a statistically significant reduction of E. coli in each type of wound.”
5. Wheeler CB, Rodeheaver GT, Thacker JG, Edgerton MT, Edilich RF. Side-effects of high pressure irrigation. *Surg Gynecol Obstet.* 1976 Nov;143(5):775-8. PMID: 982257  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=982257&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=982257&dopt=Abstract)  
“Although high pressure irrigation predisposes to the dissemination of fluids, bacteria did not accompany these fluids.” The bacterial count of the treated wounds was approximately one-hundredfold less than the original inoculum delivered to the wound.
6. Singer AJ, Hollander JE, Subramanian S, Malhotra AK, Villez PA. Pressure dynamics of various irrigation techniques commonly used in the emergency department. *Ann Emerg Med.* 1994 Jul;24(1):36-40. PMID: 8010547  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8010547&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8010547&dopt=Abstract)  
“Both 35 ml and 65 ml syringes with a 19-gauge needle are effective in performing high-pressure irrigation in the range of 25 to 35 psi. The use of IV bags and plastic bottles should be discouraged.”
7. Angeras MH, Brandberg A, Falk A, Seeman T. Comparison between sterile saline and tap water for the cleaning of acute traumatic soft tissue wounds. *Eur J Surg.* 1992 Jun-Jul;158(6-7):347-50. PMID: 1356466  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=1356466&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1356466&dopt=Abstract)  
617 adults with wounds - 90% scalp or upper extremity, 52% treated within 2 hours, 70% < 3 cm  
Infection rate: normal saline - 20.3%  
tap water - 5.4%
8. Kaczmarek ER, Sula JA, Hutchinson RA. Sterility of partially used irrigating solutions. *Am J Hosp Pharm.* 1982 Sep;39(9):1534-6. PMID: 6814247  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=6814247&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=6814247&dopt=Abstract)  
1000 cc bottles - 36 of 169 contaminated (21%)  
500 cc bottles - 16 of 105 contaminated (15%)  
Conclusion: use a sealed small bottle, then throw it away
9. Brown DG, Skylis TP, Sulisz CA, Friedman C, Richter DK. Sterile water and saline solution: potential reservoirs of nosocomial infection. *Am J Infect Control.* 1985 Feb;13(1):35-9. PMID: 3844911  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=3844911&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=3844911&dopt=Abstract)  
About 20% of opened screw-capped bottles are contaminated.
10. Hollander JE, Richman PB, Werblud M, Miller T, Huggler J, Singer AJ. Irrigation in facial and scalp lacerations: does it alter outcome? *Ann Emerg Med.* 1998 Jan;31(1):73-7. PMID: 9437345  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9437345&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9437345&dopt=Abstract)  
Irrigation before primary closure did not significantly alter the rate of infection or the cosmetic appearance in the study population with clean, noncontaminated facial and scalp lacerations. But then again, what's the big deal about just squirting them before you close??
11. Hollander JE, Singer AJ, Valentine S. Comparison of wound care practices in pediatric and adult lacerations repaired in the emergency department. *Pediatr Emerg Care.* 1998 Feb;14(1):15-8. PMID: 9516624  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=9516624&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=9516624&dopt=Abstract)  
Lacerations in children were less likely to receive irrigation (53 vs 77%; P < 0.001) but slightly more likely to be scrubbed (50 vs 45%, P = 0.01). Using logistic regression, the differences in irrigation were not explained by the differences in laceration characteristics. Despite less frequent irrigation, children had lower wound infection rates (2.1 vs 4.1%; P = 0.004) and better cosmetic appearances (optimal score, 75 vs 64%, P = 0.0003).
12. Pigman EC, Karch DB, Scott JL. Splatter during jet irrigation cleansing of a wound model: a comparison of three inexpensive devices. *Ann Emerg Med.* 1993 Oct;22(10):1563-7. PMID: 8214836  
[http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list\\_uids=8214836&dopt=Abstract](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=8214836&dopt=Abstract)  
Irrijet and Zerowet allowed significantly less splatter than a simple angiocath.