

## Additional information

Rapid Response Report: *Risks with Intravenous Heparin Flush Solutions*  
(Reference: NPSA/2008/RRR02) issued on 24 April 2008

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### Background

Intravenous heparin flushes are widely used in healthcare to keep both indwelling and peripheral lines patent. Risks with heparin flushes are not well recognised by practitioners. Risk of harm to patients can be caused through poor practice such as the use of heparin flushes which are not formally prescribed or subject to a patient group direction, mis-selection for other poorly differentiated commercial medicine products, mis-calculation and mis-preparation when a dilution of concentrated heparin product is required and mis-selection for other prepared products when placed in an unlabelled syringe before administration.

### Patient Safety Incidents

An independent report has recently been published reviewing the circumstances of four patient safety incidents where an anaesthetist mis-selected sodium heparin 25,000 units in 5 ml (Monoparin) instead of sodium heparin 50 units in 5 ml (Hepsal) and administered the more concentrated solution in unlabelled syringes to four children. Thankfully the four children only experienced some temporary bleeding and otherwise are not reported to have suffered longer term harm. However, the potential for serious harm was recognised by the Hospital Trust. The independent report provides important learning for safer practice. The report can be found at [www.ubht.nhs.uk/documents/oct\\_UBHT\\_final\\_report\\_heparin.doc](http://www.ubht.nhs.uk/documents/oct_UBHT_final_report_heparin.doc)

The NPSA has reviewed patient safety incident reports concerning mis-selection of sodium heparin products and has received 28 incident reports between January 2005 and December 2007. In addition there were also 8 reports where other medicines including diamorphine, lidocaine and magnesium were mis-selected for heparin flush solution products.

Interpretation of data from the NRLS should be undertaken with caution. As with any voluntary reporting system, the data is subject to bias. A proportion of incidents that occur remain unreported, and those which are reported may be incomplete having been reported immediately and before the patient outcome is known.

**Table 1: Patient safety incidents involving heparin flush solutions by degree of harm, January 2005 to September 2007**

Degree of harm	Incidents	%
Death/severe/moderate	0	0
Low	6	17
No Harm	30	83
Total	36	100

Source: Incidents reported to the NRLS. Incident reports were included if the incident report entered the data base between 01 January 2005 and 30 September 2007.

**Table 2: Patient safety incidents involving heparin flush solutions by stage of medication process, January 2005 to September 2007**

Medication Process	Incidents	%
Dispensing and preparation	6	17
Administration	30	83
Total	36	100

Source: Incidents reported to the NRLS. Incident reports were included if the incident report entered the data base between 01 January 2005 and 30 September 2007.

**Table 3: Patient safety incidents involving heparin flush solutions, January 2005 to September 2007**

Medication Error Category	Incidents	%
Wrong dose, strength, frequency or quantity	12	33
Wrong drug / medicine	14	39
Other	10	28
Total	36	100

Source: Incidents reported to the NRLS. Incident reports were included if the incident report entered the data base between 01 January 2005 and 30 September 2007.

Note: The category 'Other' includes 'Wrong method of preparation/ supply', 'Wrong storage', and 'Wrong formulation'.

## Example reports<sup>1</sup>

### Wrong dose of heparin flush

- When administering Intravenous (IV) antibiotic through an IV line, the line was flushed with Heparin 25,000 units in 5 mls instead of Hepsal 50 units in 5mls. This was noticed immediately. 20 mls was withdrawn and the line then flushed with Hepsal. Outcome: No Harm.
- A central venous catheter was flushed with Heparin instead of Hepsal. Blood was taken to check clotting. Outcome: No harm.
- During the insertion of a Vas-cath, four heparin 5,000 units / ml x 5ml ampoules was requested. This was queried and confirmed as correct. The ampoules were double checked and most of the heparin was to flush the Vas-cath ports. Following insertion of the Vas-cath the clotting became very prolonged and the patient developed a haematoma over each clavical, insertion having been attempted on both sides. The patient had routine chest x-ray and clotting checked overnight. Outcome: Low Harm.
- Multiparin was dispensed in error instead of Hepsal. The dose given is unclear. Outcome: No Harm
- A patient was prescribed 5 ml Hepsal flush in a Hickman line after receiving IV medication – 5 ml heparin 5000 units was given by mistake (the strength of Hepsal was not prescribed on drug chart. Outcome: No Harm.
- During a Percutaneous Coronary Intervention (PCI) procedure a syringe labelled Heparin was taken and used as a flush. As the syringe was refilled with normal saline before the error was noticed it is unclear how much heparin was administered. Outcome: No Harm.

### Wrong medicine instead of heparin flush

- Diamorphine 40 mg administered to a patient instead of 5 ml of Hepsal . Outcome: No Harm
- A long line flushed with Lidocaine 1 % (10 mls) instead of Hepsal 10 mls. Outcome: Low Harm.
- A patient required her Hickman line to be flushed. Equipment was prepared according to protocol. The two members of staff double checked the vial intended to be used for flushing and discovered it was magnesium sulphate and not Hepsal. Outcome: No Harm.

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<sup>1</sup>The examples used throughout this report are taken from incidents reported to the NRLS by NHS staff in England and Wales.

## Evidence of safety and effectiveness of heparin and alternatives

The UK Medicines Information (UKMi) released in April 2008 a Q&A on heparin flushes. The UKMi is an NHS pharmacy based service which aims to support the safe, effective and efficient use of medicines by the provision of evidence-based information and advice on their therapeutic use. The evidence-based Q&As on key issues around medicines safety and effectiveness are posted on the National Electronic Library for Medicines.

The full Q&A is given as Annex 1 to this supporting information – the full review of literature is available at: [www.druginfozone.nhs.uk/Record%20Viewing/viewRecord.aspx?id=591809](http://www.druginfozone.nhs.uk/Record%20Viewing/viewRecord.aspx?id=591809)

There is evidence available to address the question of whether heparin has any advantage over saline solution to flush peripheral intravenous catheters to reduce the risk of blockage and the need for replacement. The research identifies other issues that may impact on catheter patency including flush technique, patient's age and site of cannulation.

- ◆ There seems to be a reasonable consensus that heparin solutions have no advantage over normal saline for maintaining peripheral intravenous catheters. This is also noted in the British National Formulary (section 2.8.1) (35).
- ◆ For arterial and for central venous catheters, the picture is less clear and more specific policies may be required depending on the individual devices in use.

## Conclusions

This Rapid Response Report has identified a number of incidents of harm or potential harm from heparin flushes. These are used commonly to keep peripheral and central lines open and are often not viewed as high risk.

Evidence confirms that there is no advantage over normal saline for maintaining peripheral intravenous catheters. For more complex devices, such as central venous or arterial catheters, the evidence is less clear. More specific policies may be required locally depending on the individual devices in use.

## Other ongoing safety work

The NPSA is working with a range of stakeholders to further define and develop safer practice. For example a project is being undertaken with the Royal College of Anaesthetists to review methods of double checking medicines and the use of a redesigned anaesthetic workstation.

## Further Information

Support information on this *Rapid Response Report*, is available at [www.npsa.nhs.uk/patientsafety](http://www.npsa.nhs.uk/patientsafety) or David Cousins Head of Safe Medication Practice, [c/o rrr@npsa.nhs.uk](mailto:c/o_rrr@npsa.nhs.uk) Telephone 020 7927 9356.

## ANNEX ONE:

### NHS UK Medicines Information

#### Medicines Q&As – April 2008 Should heparin based flushing solutions be used in preference to saline to maintain the patency of indwelling intravascular catheters and cannulae?

Prepared by UK Medicines Information ([UKMi](#)) pharmacists for NHS healthcare professionals  
Expiry: 31<sup>st</sup> March 2010

#### Background

The use of peripheral intravascular catheters to provide access for the administration of medicines, fluids and parenteral nutrition, and providing access for venepuncture and monitoring is widespread. Maintenance of their patency is important to reduce the discomfort and expense of replacement. It is common practice to flush the catheters with solutions of various strengths of heparin in saline (0.9% sodium chloride injection), before and after use (phlebotomy or drug administration), in order to reduce the risk of clots forming in the lumen and hence to maintain their patency.

Unnecessary exposure to heparin should be avoided as there are risks and disadvantages (1,2) in using these products including:

- ◆ Allergic reactions
- ◆ The potential for bleeding complications
- ◆ Risk of medication error
- ◆ Risk of heparin induced thrombocytopenia
- ◆ Cost

Another disadvantage is if a heparin based flushing solution is used then it may also be necessary to flush the device with a separate saline flush before and after administering medicines that are incompatible with heparin (2).

There is a distinction between “simple” peripheral intravenous venous catheters and more complex devices such as central venous or arterial catheters. Peripheral venous catheters have low volumes and, typically, are required to last only for a few hours or days during an in-patient stay. Other indwelling devices can have larger volumes and pose other problems as they may be required to remain *in situ* for longer periods of time whilst being accessed far less frequently.

#### Answer

There are many studies in this area as well as a number of systematic reviews and evidence based guidelines. These are summarised in Table 1. There is a degree of heterogeneity in the studies; in the flushing technique, the duration of study, the strength of heparin used and in the precise way that catheter patency is assessed. The evidence is discussed in terms of the particular kind of device being used. Whilst some of the individual studies have methodological limitations e.g. some are non-randomised or do not use intention-to-treat analysis, there are some systematic reviews and meta-analyses that can be used to provide definitive advice where the evidence is available.

#### Devices providing peripheral venous access in adults

The general finding of research in this area of practice is that using heparin based flushing solutions does not have any advantage, in terms of patency rates, over using saline (2-10). The catheter gauges studied, where stated, included 18-22 gauge. Two studies in pregnant women (4, 8) disagree in their findings; one study demonstrated no difference in catheter life over the study period of 12 hours (4). The second study showed that a heparin based flushing solution (100 units/mL) was significantly better than saline at 48 and 72 hours (8). The risk of phlebitis with heparinised saline varies between studies.

### **Devices providing peripheral venous access in children and neonates**

There are some studies looking specifically at devices, which are generally of a narrower gauge (22 and 24 gauge), used in children and

neonates (11-16). As in adults, the general conclusion of this research is that heparin confers no advantage over saline. These studies highlight other determinants that affect the risk of device blockage such as the gestational age of neonates/age of children and the site used for cannulation (11-15). A non-randomised study reports a statistically significant advantage of heparin over saline in babies (16).

### **Central Venous Catheters**

The research in this area is more limited and individual studies have looked at specific devices. The findings are mixed with some studies concluding that heparin provides no advantage in maintaining the patency of indwelling central venous catheters used for chemotherapy (17), apheresis (18) and triple lumen central catheters used in intensive care (19). Other studies provide contradictory results for Groshong catheters used for oncology in-patients and out-patients (20) and central venous lines (21,22).

### **Arterial Catheters**

In these catheters, a flushing solution is continuously infused through the line. The findings of research in this area are mixed. A number of studies have found that heparin confers advantages in maintaining the patency of arterial catheters and also providing more accurate blood pressure readings (23-26). One study however reports no difference between arterial lines flushed with heparin and saline solutions (27).

### **Reviews and Evidence Based Guidelines**

Reviews that address peripheral IV catheters in adults (28-31) conclude that heparinised saline solutions have no advantage over normal saline for maintaining peripheral venous catheters. The Cochrane Review (32) however concludes that there is insufficient evidence in neonates for firm recommendations about heparin to be made.

For arterial catheters and for central venous lines, the picture is less clear (28,31,33,34). An evidence based guideline published in 2007 (33) notes that heparin has a role in maintaining these catheters but, due to their heterogeneity, specific policies will probably need to be devised for individual circumstances. A number of factors are important including the volume of the catheter, any specific manufacturer's recommendations, the presence of valves and the need to remove flushing solutions prior to use.

### **Summary**

There is evidence available to address the question of whether heparin has any advantage over saline solution to flush peripheral intravenous catheters to reduce the risk of blockage and the need for replacement. The research identifies other issues that may impact on catheter patency including flush technique, patient's age and site of cannulation.

- ◆ There seems to be a reasonable consensus that heparin solutions have no advantage over normal saline for maintaining peripheral intravenous catheters. This is also noted in the British National Formulary (section 2.8.1) (35).
- ◆ For arterial and for central venous catheters, the picture is less clear and more specific policies may be required depending on the individual devices in use.

### **Limitations**

The studies cited vary in their design, for example in -

- ◆ The frequency of flushing of catheters
- ◆ The volumes of flushing solutions used
- ◆ The catheter type studied
- ◆ The duration of time that catheter function was assessed
- ◆ The concentration of heparin used.

No attempt is made here to recommend the optimal flushing regimen in terms of the volume, frequency or technique best employed.

**Disclaimer**

- Medicines Q&As are intended for healthcare professionals and reflect UK practice.
- Each Q&A relates only to the clinical scenario described.
- Q&As are believed to accurately reflect the medical literature at the time of writing.
- See [NeLM](#) for full disclaimer.

**Table 1: References, Summary of Evidence and Cited References**

**Key to abbreviations used in the table**

DB = Double Blind                      RCT = Randomised Controlled Trial  
 vs = versus                              NS = Normal Saline (0.9% Sodium Chloride Injection)  
 Hep = Heparin                          Sig Diff = Statistically Significant Difference  
 Inj = injection                          IV = Intravenous                      IA = Intra-arterial

Ref	Title	Authors	Reference	Comments
1	Meyler's Side Effects of Drugs Elsevier	Aronson JK, editor	15th Ed, 2006. 1590-1591.	Review of adverse effects of heparin.
<b>Studies on peripheral intravenous device in adults</b>				
2	Heparin versus saline flushing solutions in a small community hospital.	Barret PJ, Lester RL	Hosp Pharm. 1990;25:115-118	DB Cross Over study of 109 catheter removals. NS vs Hep 10 units/mL in NS No Sig Diff in loss of catheter patency. Hep caused more (Sig Diff) phlebitis.
3	Efficacy of 0.9% sodium chloride injection with and without heparin for maintaining indwelling intermittent injection sites	Epperson EL	Clin. Pharm. 1984;3:626-9	DB RCT in 412 patients. NS vs Hep 10 units/mL in NS vs Hep 100 units/mL in NS No Sig Diff found between the three groups in duration of catheter placement or phlebitis.
4	The effects of heparin versus normal saline for maintaining peripheral intravenous locks in pregnant women.	Niesen KM et al	J Obstet Gynecol Neonatal Nurs. 2003;32:503-508	DB RCT in 73 patients NS vs Hep 10 units/mL in NS No Sig Diff in IV lock patency or phlebitis.
5	Comparison of heparin and 0.9% sodium chloride injection in the maintenance of indwelling intermittent i.v. devices.	Garrelts JC et al	Clin Pharm 1989;8:34-39	DB RCT in 147 patients. NS vs Hep 10 units/mL in NS. No Sig Diff in site loss due to phlebitis or loss of catheter patency.
6	Heparin sodium versus 0.9% sodium chloride injection for maintaining patency of indwelling intermittent infusion devices.	Hamilton RA et al	Clin Pharm 1988;7:439-443	DB RCT in 160 patients. NS vs Hep 100 units/mL in NS No Sig Diff in duration of catheter patency or phlebitis.
7	Flushing solutions for indwelling intravenous catheters.	Shaw P, Baker D	Pharm J 1988;241:122-3	DB Sequential Cross Over Study in 566 patients. NS vs Hep 10 units/mL in NS No Sig Diff in duration of catheter placement or numbers of catheter sites lost due to blockage, phlebitis or tissueing.
8	Heparin versus normal saline as a peripheral line flush in maintenance of intermittent intravenous lines in obstetric patients.	Meyer BA et al	Obstet Gynecol 1995;85:433-436	DB RCT in 64 patients. NS vs Hep 100 units/mL Sig Diff increased patency rates at 48 and 72h with Hep.
9	Efficacy of sodium chloride versus dilute heparin for maintenance of peripheral intermittent intravenous devices.	Tuten SH, Gueldner SH	Appl Nurs Res 1991;4:63-71	Quasi experimental study of 77 patients. NS vs Hep 100 units/mL No Sig Diff seen in rates of catheter loss, phlebitis or infiltration.

10	Effects of heparin versus saline solution on intermittent infusion device irrigation.	Ashton J et al	Heart Lung 1990;19:608-612	DB RCT in 32 patients NS vs Hep 10 units/mL in NS (both solutions also contained 1% benzyl alcohol). No Sig Diff in phlebitis or catheter patency.
<b>Studies on peripheral venous devices in children and neonates</b>				
11	A randomized controlled trial for maintaining peripheral intravenous lock in children.	Mok E et al	Int J Nurs Prac 2007; 13: 33-45	DB RCT in 123 patients (age 1-10 years) NS vs Hep 1 units/mL vs Hep 10 units/mL No Sig Diff found between the three groups in catheter life or IV complications.
12	Intermittent intravenous therapy: a comparison of two flushing solutions.	Robertson J	Contemp Nurse 1994;3:174-179	Single blind RCT in 152 patients (age 2 months-18 years). NS vs Hep 1 unit/mL No Sig Diff in catheter patency. Younger children more likely to have blocked catheters.
13	The use of heparin and normal saline flushes in neonatal intravenous catheters.	Paisley MK et al	Pediatr Nurs 1997;23:521-524	Study "Quasi experimental design" of 87 patients (gestational age $\geq$ 32 weeks). NS vs Hep 10 units/mL No Sig Diff between groups in duration of catheter patency. Age and site of insertion major determinants of duration of patency.
14	Heparin vs saline for intermittent intravenous device maintenance in neonates.	Kotter RW	Neonatal Netw 1996;15:43-47	DB RCT in 51 patients (gestational age 27-42 weeks). NS vs Hep 10 units/mL in NS No Sig Diff seen between groups in average duration of patency. Rate of phlebitis, occlusion, infiltration and leaking also similar.
15	Efficacy of normal saline solution versus heparin solution for maintaining patency of peripheral intravenous catheters in children	Le Duc K	J Emerg Nurs 1997;23:306-9	DB RCT in 150 patients (mean age 5.5 years) NS vs Hep 10 units/mL NS No Sig Diff between groups for catheter patency or phlebitis.
16	Patency of 24-gauge peripheral intermittent infusion devices: a comparison of heparin and saline flush solutions.	Mudge B et al	Pediatr Nurs 1998;24:142-145	Non randomised sequential blinded study of 61 patients (84% age < 2 months). NS vs Hep 10 units/mL NS Sig Diff seen between groups with Hep more effective in retaining patency of catheters.
<b>Studies on central venous catheters</b>				
17	Maintenance of the patency of indwelling central venous catheters: is heparin necessary?	Smith S et al	Am J Pediatric Hematol Oncol 1991;13:141-143	Randomised cross over study of 14 patients. NS (weekly) vs Hep 10 units/mL NS (twice daily) No Sig Diff between two methods in catheter patency/blockage.
18	Normal saline versus heparin flush for maintaining central venous catheter patency during apheresis collection of peripheral blood stem cells (PBSC).	Stephens LC et al	Transfus Sci 1997;18:187-193	Non-randomised study of 86 patients NS vs Hep 100 units/mL in NS. No Sig Diff in thrombotic catheter occlusions seen between two groups.

19	Comparative study of maintenance of patency of triple lumen central venous catheter.	Fuentes IPC et al	Enferm Intensiva 2007;18:25-35	Two phase study. 1. Blind RCT in 128 catheters. Hep 500 units/5mL vs Hep 100 units/5mL No Sig Diff in loss of catheter patency. 2. Blind RCT in 95 catheters NS 5mL vs Hep 100 units/5mL No Sig Diff in loss of catheter patency.
20	The effects of heparin flush on patency of the Groshong <sup>®</sup> catheter: A pilot study.	Mayo DJ et al	Oncol Nurs Forum 1996;23:1401-1405	Non randomised study of weekly flushes of indwelling venous catheters in 51 patients. NS vs Hep 100units/mL Sig Diff seen between groups as Hep maintained catheters had better patency than NS maintained ones.
21	Keeping central venous lines open: a prospective comparison of heparin, vitamin C and sodium chloride sealing solutions in medical patients.	Rabe C et al	Intensive Care Med 2002;28:1172-1176	RCT in 99 catheters. NS vs Hep 5000 units/mL vs Vitamin C 200mg/mL. Hep superior to NS and Vitamin C (Sig Diff). Vitamin C did not prolong catheter patency compared to NS.
22	The efficacy of heparinization in prolonging patency of arterial and central venous catheters in children: A randomized double-blind trial	de Neef M et al	Pediatr Hematol Oncol 2002;19:553-560	DB RCT in 300 patients (mean age 53 months) NS vs Hep 1 unit/mL NS (continuous infusion at 2-3 mL/h) Sig Diff seen between groups with increased risk of arterial catheter non-patency with saline. No Sig Diff seen between groups for venous catheters.
<b>Studies on arterial catheters</b>				
23	Comparison of normal saline and heparin solutions for maintenance of arterial catheter patency.	Clifton GD et al	Heart Lung 1991;20:115-118	DB RCT in 30 patients. NS vs Hep 4 units/mL in NS (continuous flow rate 3mL/hr) Sig Diff in catheter survival rate with Hep use resulting in longer catheter patency.
24	Heparinized saline versus normal saline in maintaining patency of the radial artery catheter.	Kulkarni M et al	Can J Surg 1994;37:37-42	DB RCT in 78 patients. NS vs Hep 2 units/mL in NS (continuous flow rate 3mL/h) No Sig Diff in arterial line patency but more catheters blocked in NS group. BP measurement was more accurate measured via heparinised lines
25	Comparison of heparinized and non-heparinized solutions for maintaining patency of arterial and pulmonary artery catheters.	Zevola DR et al	Am J Crit Care 1997;6:52-55	Non-randomised, non-blinded study of 226 patients NS vs Hep 1 unit/mL No Sig Diff between groups in catheter failure rates seen with pulmonary catheters. Sig Diff seen with arterial catheters with Hep leading to fewer failures.
26	Evaluation of the effects of heparinized and nonheparinized flush solutions on the patency of arterial pressure monitoring lines: the AACN Thunder Project <sup>®</sup> .	American association of Critical care Nurses	Am J Crit Care 1993;2:3-15	RCT in 5037 patients. NS vs Hep (strength not specified) Sig Diff seen between groups with Hep flushes associated with better patency. Other determinants also identified.
27	Comparison of normal or heparinised saline flushing on function of arterial lines.	Whitta RKS et al	Crit Care Resusc 2006;8:205-208	RCT in 65 patients. NS vs Hep 1 unit/mL (continuous flow rate 3mL per hour)

				No Sig Diff in arterial catheter function.
<b>Reviews, Meta-analyses and Evidence Based Guidelines (all areas)</b>				
28	Analysis of the research about heparinized versus nonheparinized intravascular lines.	Peterson FY, Kirchoff, KT	Heart Lung 1991;20:631-40	Review of 20 relevant studies. 13 put into meta-analysis. No significant difference between heparin and saline flush procedures in peripheral IV catheters. Data on arterial catheters are inconclusive.
29	A meta-analysis of effects of heparin and saline flush: quality and cost implications.	Goode CJ et al	Nurs Res 1991;40:324-30	Meta-analysis of 13 studies. Saline is as effective as heparin in maintaining patency, preventing phlebitis and increasing duration of peripheral IV locks. Increased safety and reduced costs are also benefits.
30	Benefit of heparin in peripheral venous and arterial catheters: systematic review and meta-analysis of randomised controlled trials	Randolph AG et al	British Medical Journal 1998; 316: 969-975	Critical appraisal and meta-analysis of 26 RCTs. Flushing peripheral IV catheters with heparinised saline at 10 units/mL is no more beneficial than flushing with normal saline. Heparin, when added to the continuously infused solutions, significantly prolongs the duration of peripheral arterial catheter patency.
31	NICE Guideline CG 2. Prevention of healthcare associated infections in primary and community care.	National Institute of Health and Clinical Excellence	NICE Guideline CG 2. June 2003	This guideline reviews the general evidence base for the use of intermittent intravenous flushes of heparin solution compared to saline. The guideline makes the following recommendations <ul style="list-style-type: none"> <li>◆ Preferably, a sterile 0.9% solution of sodium chloride, should be used to flush and lock catheter lumens</li> <li>◆ When recommended by the manufacturer, implanted ports or open ended catheter lumens should be flushed and locked with heparin flush solutions</li> </ul>
32	Heparin for prolonging peripheral intravenous catheter use in neonates	PS Shah, et al	Cochrane Database of Systematic Reviews. 2005, Issue 4.	The effect of heparin on the duration of peripheral intravenous catheter use varied across the studies. Because of clinical heterogeneity and heterogeneity in treatment effect, recommendations for heparin use in neonates with PIV catheters cannot be made.
33	Guidelines on the insertion and management of central venous access devices in adults.	Bishop L et al	Int. J. Lab. Hematol 2007;29;261-278	Review of published studies and other guidelines. The review covers central venous catheters, apheresis catheters, implanted ports and peripherally inserted central catheters. Flushing with heparin versus normal saline remains controversial. Heparin exposure should be minimised. A positive pressure method of flushing (by protocol, according to the type of catheter) is essential to maintain catheter patency. The review makes more specific recommendations for individual catheter types.

34	Effectiveness of heparin versus NaCl 0.9% in central venous catheter flushing. A systematic review.	Lopez-Briz E, Ruiz-Garcia V	Farm Hosp. 2005;29:258-264	Systematic Review including two clinical trials. Weak evidence supports the greater effectiveness of heparin over saline. More evidence is needed.
35	British National Formulary, London: British Medical Association & The Royal Pharmaceutical Society of Great Britain	Martin J, editor	No. 54, Sept 2007, p124	Information on heparin flushes

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#### Date of check

28th March 2008

#### Search strategy

- ◆ Medline 1950 to date: [(HEPARIN.W..DE AND CATHETERS-INDWELLING.DE OR CATHETERS-CENTRAL-VEINUS.DE) (SODIUM-CHLORIDE.DE)]
- ◆ Medline 1950 to date: [(SODIUM-CHLORIDE.DE AND CATHETERIZATION OR CATHETERS-INDWELLING.DE OR CATHETERS-CENTRAL-VEINUS.DE AND "flush")]
- ◆ Embase 1974 to date: [(HEPARIN.W..DE AND CATHETER.W.DE AND "flush")]
- ◆ Search Engine – Google Scholar: ["heparin", "catheter", "flush", ("sodium chloride" or "saline")]
- ◆ PharmLine: ["heparin", "sodium chloride" AND "flush", "catheters"]

