

Heparin titration is hard: let the app do the work!

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The Problem

Heparin is a high risk medication used as an anticoagulant and prevents the blood from clotting. Heparin infusions are a constant challenge for both medical and nursing staff to manage. Within Hunter New England LHD, there is a process where nursing staff are able to titrate the rate of heparin infusion based on blood test results, namely the activated partial thromboplastin time, or APTT which is the time it takes for the blood to clot.

A heparin infusion titration table was developed in 2011, along with a purpose designed titration chart and clinical guideline. Haematology and clinical pharmacology were involved in the development of the process to ensure accuracy and consensus, but somehow, we were having difficulty conveying the information and process. The LHD saw an average of three errors per month related to clinicians not following the multistep process and confusing the sequential steps.

aPTT (seconds)	Infusion rate change mL/hour (of 25000 units in 50 mL = 500 unit/mL)
Less than 50 seconds	Give another single bolus of 5000 units IV & increase infusion rate ONCE by 0.5 mL/h then recheck aPTT after 6 hours
50-55 seconds	Increase infusion rate ONCE by 0.5 mL/h then recheck aPTT after 6 hours
56-59 seconds	Increase infusion rate ONCE by 0.2 mL/h then recheck aPTT after 6 hours
60-80 seconds	No change and recheck aPTT after 24 hours
81-100 seconds	Decrease infusion rate ONCE by 0.1 mL/h then recheck aPTT after 6 hours
101-120 seconds	Stop infusion for 30 min, then decrease infusion rate ONCE by 0.2 mL/h then recheck aPTT after 6 hours
Greater than 120 seconds	If aPTT persistently greater than 100 seconds seek Haematology advice Stop infusion for 2 hours, recheck aPTT - Do not restart heparin until the aPTT is back If aPTT is more than 100 seconds, do not restart infusion, seek Haematology advice If aPTT is less than or equal to 100 seconds - restart infusion but at a decreased rate. Reduce rate ONCE by 0.4 mL/h - i.e. new rate 0.4 mL/h lower than the rate prior to stopping infusion. Do not give bolus Recheck aPTT after 6 hours

Figure 1. Original heparin titration table from 2011

The Cause

One particular worrying trend was identified, caused by a breakdown in the process. In patients whose aPTT was returning a result greater than 120 seconds, the nursing staff were completing the first step on the process – ceasing the infusion for 2 hours and rechecking the aPTT, but were not completing the subsequent steps in the process. Rather than reducing the rate by 0.4 mL/hr, they were skipping straight to the process for the aPTT result which was returned, which could include a bolus and rate increase. On further investigation of the adult heparin infusion charts, we found that 65% of heparin infusions were being titrated incorrectly.

The Failure

To address this issue, the information was repackaged into the colourful flow chart below. The theory we were working with was that if the information was presented as a flow chart, rather than a table, staff were more likely to view and read all of the information rather than skipping to different sections.

Heparin Infusion Titration Table - For Heparin Sodium Infusion (Adult) 500 units/mL - Pathology North Sites ONLY	Step 1	Loading Dose - bolus 5000 units heparin sodium											
	Step 2	Initial infusion rate as per HNE Clinical Guideline - Heparin Sodium Intravenous Loading Dose and Infusion (Adult)											
	Step 3	Check aPTT six hours after commencement of infusion and adjust as required											
Less than 50 Seconds	Give another single bolus of 5000 units IV heparin	50 - 55 Seconds	Increase infusion rate ONCE by 0.5 mL/h	56 - 59 Seconds	Increase infusion rate ONCE by 0.2 mL/h	60 - 80 Seconds	No change in infusion rate	81 - 100 Seconds	Decrease infusion rate ONCE by 0.1 mL/h	101 - 120 Seconds	Stop infusion for 30 minutes, decrease infusion rate ONCE by 0.2 mL/h	Greater than 120 Seconds	Stop infusion for 2 hours
	Increase the infusion rate ONCE by 0.5 mL/h		Recheck aPTT after 6 hours		Recheck aPTT after 6 hours		Recheck aPTT after 24 hours		Recheck aPTT after 6 hours		After 30 minutes, decrease infusion rate ONCE by 0.2 mL/h		After 2 hours, recheck aPTT
	Recheck aPTT after 6 hours										Do not restart infusion until aPTT result is back		Do not restart infusion until aPTT result is back
											If aPTT is 100 seconds or less, decrease infusion rate ONCE by 0.4 mL/h (do NOT give bolus) and recheck after 6 hours		If aPTT is more than 100 seconds after 2 hours, seek haematology advice

Figure 2. Heparin titration flow chart

But it didn't work.

It didn't change anything.

The same incidents still occurred. We decided that we needed to look at a solution where we restrict the amount of information shown to clinicians. This may sound counter-intuitive, however displaying too much information seemed to be causing information overload, which resulted in staff not reading the instructions fully.

The Solution – an app!

This time around we decided to force the user to enter some information – the current aPTT and the previous aPTT. Both results were used to display the correct steps on a web page and the unnecessary information is completely hidden.

First, we developed a decision matrix spreadsheet. In simple terms, just an excel document which outlined a total of 56 possible combinations of current and previous aPTT ranges. Each of the 56 combinations had between 2 and 4 steps as their outcome. Next, we used JavaScript to program our webpage, CSS to style it and HTML to build it. These languages all work in different ways to make a web page or app interactive. HTML displays the words on the page, CSS makes them pretty by adding fonts, colours and text size while JavaScript performs the calculations in the background and displays the correct information for the user to follow.

The Outcome

Since the rollout and implementation of the new process, the incidents of medication errors involved in heparin infusions fell from 3 per month throughout the district to zero since April 2017.

Heparin Infusion Titration Table (For Heparin Sodium Infusion (Adult) 500 units/mL - Pathology North Sites ONLY)

CAUTION

This Heparin Infusion Titration Table is to be used ONLY:

- By those sites serviced by Pathology North
- In conjunction with HNE Clinical Guideline for Heparin Sodium Intravenous Loading Dose and Infusion (Adult) As a reference range for aPTT when adjusting Heparin Sodium Infusion (Adult) 500 units/mL
- When using the HNE Adult Intravenous Heparin Infusion chart (21HEHNEMR87)
- For aPTT target range of 60 to 80 seconds only

Infusion instructions:

- Loading dose: heparin sodium 5,000 units bolus
- Initial infusion rate (for the first six hours) via syringe driver is according to actual patient weight - see HNE Clinical Guideline for Heparin Sodium Intravenous Loading Dose and Infusion (Adult)
- Infusion rate adjustment instructions:
 - Check aPTT six hours AFTER commencement of Heparin Sodium Infusion 500 units/mL
 - Adjust rate of Heparin Sodium Infusion 500 units/mL according to the following aPTT result/range and stratification (table below)
 - Recheck aPTT as instructed and make further infusion rate adjustment qdy if necessary

Additional notes:

- The reagent used by Pathology North may change, which will affect the aPTT reference range. This titration table will be updated as the reagent changes and is current as at 15th December 2015
- Patient assessment, precautions, loading dose, initial infusion rate and other information regarding the commencement of Heparin treatment is found within the relevant HNE Health Clinical Guideline or reference texts.
- For sites that are NOT serviced by Pathology North refer to local guidelines or the pharmacy servicing your site.

Heparin Infusion Titration Table - For Heparin Sodium Infusion (Adult) 500 units/mL - Pathology North Sites ONLY

Step 4 Click on the aPTT range below

Current aPTT [50 to 60 seconds] Previous aPTT [Greater than 120 seconds] [Calculate]

* Reduce infusion rate ONCE by 0.4 mL/h
* Recheck the aPTT after 6 hours

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Step 4 Click on the aPTT range below

Current aPTT [Less than 50 seconds] Previous aPTT [60 to 80 seconds] [Calculate]

* Increase the infusion rate ONCE by 0.5 mL/h
* Give another single bolus of 5000 units IV
* Recheck the aPTT after 6 hours

Heparin Infusion Titration Table - For Heparin Sodium Infusion (Adult) 500 units/mL - Pathology North Sites ONLY

Step 4 Click on the aPTT range below

Current aPTT [60 to 80 seconds] Previous aPTT [60 to 80 seconds] [Calculate]

* No change in infusion rate
* Recheck the aPTT after 24 hours

Figure 3. Heparin titration app