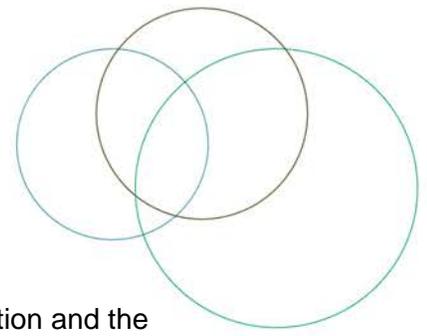


HOSPITAL HARM IMPROVEMENT RESOURCE

Infusion, Transfusion and Injection Complications



ACKNOWLEDGEMENTS

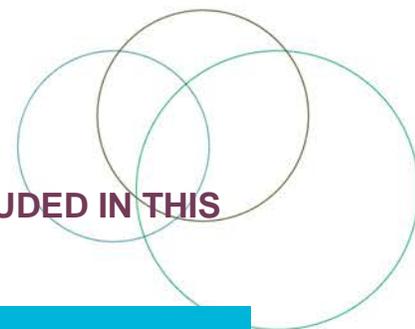


The Canadian Institute for Health Information and the Canadian Patient Safety Institute have collaborated on a body of work to address gaps in measuring harm and to support patient safety improvement efforts in Canadian hospitals.

The Hospital Harm Improvement Resource was developed by the Canadian Patient Safety Institute to complement the Hospital Harm measure prepared by the Canadian Institute for Health Information. It links measurement and improvement by providing evidence-informed resources that will support patient safety improvement efforts.

The Canadian Patient Safety Institute acknowledges and appreciates the key contributions of Leonor De Biasio, RN BScN CPN(C), Clinical Project Coordinator-Transfusion Safety Nurse, Ontario Regional Blood Coordinating Network (ORBCoN) Central Region; and Kelly Syer RN, BScN, Transfusion Safety Officer, Lakeridge Health, for the review and approval of this Improvement Resource.



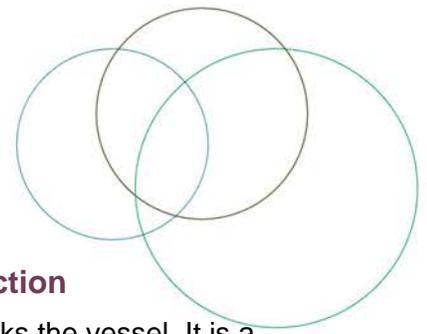


DISCHARGE ABSTRACT DATABASE (DAD) CODES INCLUDED IN THIS CLINICAL CATEGORY:

A11: Infusion, Transfusion and Injection Complications

Concept	Complications from infusions, transfusions and injections, including those related to therapeutic substances or procedures.	
Notes	This clinical group excludes venous thromboembolism, electrolyte and fluid imbalance, infection, trauma, and pneumothorax due to infusions, transfusions and injections (refer to A06: Venous Thromboembolism, A09: Electrolyte and Fluid Imbalance, B13: Post-Procedural Infections, D19: Patient Trauma and D22: Pneumothorax).	
Selection criteria	T80.0 T80.1 T80.3 T80.4 T80.5 T80.6 T80.8 T80.9	Identified as diagnosis type (2)
Exclusions	Events selected from a diagnosis cluster that is also selected for A06: Venous Thromboembolism, A09: Electrolyte and Fluid Imbalance, B13: Post-Procedural Infections, D19: Patient Trauma or D22: Pneumothorax.	
Codes	Code descriptions	
T80.0	Air embolism following infusion, transfusion and therapeutic injection	
T80.1	Vascular complications following infusion, transfusion and therapeutic injection	
T80.3	ABO incompatibility reaction	
T80.4	Rh incompatibility reaction	
T80.5	Anaphylactic shock due to serum	
T80.6	Other serum reactions	
T80.8	Other complications following infusion, transfusion and therapeutic injection	
T80.9	Unspecified complication following infusion, transfusion and therapeutic injection	





OVERVIEW AND IMPLICATIONS

Air embolism following infusion, transfusion and therapeutic injection

An air embolism is a bubble that becomes trapped in a blood vessel and blocks the vessel. It is a rare but potentially fatal event. The seriousness of the blockage depends on which part of the body the affected blood vessel supplies blood to, and the size of the air bubble. For example, an air embolism in the arteries leading to the brain may cause a decreased level of consciousness, dizziness, slurred speech, seizures, and/or a stroke. An air embolism that travels to the coronary arteries may cause a myocardial infarction or an arrhythmia. An air embolism that travels to the lungs may cause a pulmonary embolism (Gordy & Rowell, 2013; National Health Service, 2015).

Vascular complications following infusion, transfusion and therapeutic injection

Phlebitis refers to inflammation of the vein and it may be a complication of peripheral cannulation. Phlebitis may be painful, and it compromises future venous access. Other symptoms include warmth, tenderness, erythema or palpable venous cord. If it is bacterial and untreated, it may lead to a bloodstream infection. Phlebitis may be localized to the insertion site or travel along the vein. It may occur during catheterization or up to 48 hours after cannula removal (Ray-Burrue et al., 2014).

ABO incompatibility reaction

Acute hemolytic transfusion reaction is a possible complication of a blood transfusion. It may be associated with **ABO-incompatibility, other blood group incompatibilities** (there are 29 blood group systems, in addition to ABO, that may cause incompatibility), and with rare cases when group O platelets with high titers of anti-A and/or anti-B are transfused to a non-group O recipient (Callum et al., 2016; Fung et al., 2007).

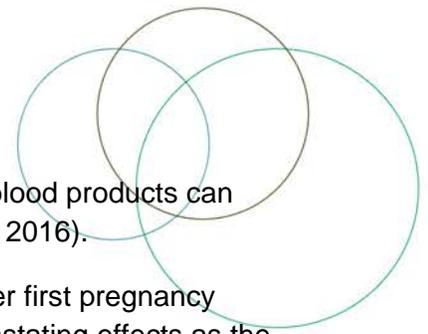
ABO-incompatibility is the most common cause of morbidity from RBC transfusion. The reaction is often due to a clerical error, or an error in patient identification. Half of all errors are due to administering properly labelled blood to the wrong patient, while other errors are the result of improper labelling of samples or testing errors. One in 38,000 red cell transfusions are ABO-incompatible due to transfusing the wrong blood to a patient, and less than 10 per cent of ABO-incompatible transfusions result in a fatal outcome. The risk of death correlates with the amount of incompatible blood transfused (Callum et al., 2016).

Symptoms of hemolytic reaction include back pain, bloody urine, chills, fainting or dizziness, fever, flank pain and flushing of the skin (National Heart Lung and Blood Institute, 2011, Transfusion reaction, 2016).

Rh incompatibility reaction

Rh is known as the D antigen. Less than 15 per cent of the population do not have this antigen expressed on their red blood cells and are typed as D negative, more commonly known as Rh negative. If an Rh negative person is exposed to Rh positive blood, either by a blood transfusion or their fetus during pregnancy, a small percentage will form an antibody to the D antigen (Anti-





D). If the patient does develop anti-D, subsequent exposures to Rh positive blood products can produce a hemolytic reaction (Ontario Regional Blood Coordinating Network, 2016).

In the case of pregnancy, if an Rh negative mother develops Anti-D during her first pregnancy with an Rh positive baby, her second or subsequent babies could suffer devastating effects as the anti-D in her plasma may attack the D-antigen on the surface of the baby's red cells causing hemolysis. This is a known cause of hemolytic disease of the fetus and newborn (HDFN). An infant with HDFN may show signs of anemia, jaundice, hypotonia, lethargy, or in some cases, brain damage or even death can occur. The administration of Rh Immune globulin (Rhogam) during prenatal care can reduce the likelihood of developing Anti-D, which would affect future pregnancies (Ontario Regional Blood Coordinating Network, 2016).

Anaphylaxis to serum

Anaphylactic shock can result from a blood transfusion. It is the most severe form of allergic reaction and accounts for approximately three per cent of transfusion associated fatalities (Food and Drug Administration, 2009). The occurrence rate for anaphylaxis is rare at one in 40,000. The vast majority of anaphylactic reactions are unexplained (Callum et al., 2016).

Anaphylactic/anaphylactoid reactions usually begins within one to 45 minutes of the start of the infusion and are associated with cutaneous reactions (urticaria), hypotension, hypoxia, hoarseness, stridor, wheezing, chest pain, dyspnea, anxiety, feelings of impending doom, gastrointestinal symptoms (nausea, vomiting) and rarely death (Callum et al., 2016).

Other serum reactions

Urticaria may present as one lesion or be widespread lesions. Urticaria may be associated with pruritus, erythema, flushing or mild upper respiratory symptoms (cough, wheezing), nausea, vomiting, abdominal cramps or diarrhea (Callum et al., 2016). Minor allergic reactions affecting the skin with occurrence of hives, rash, and urticaria are far more common occurring at a rate of one in 100 blood products transfused (Callum et al., 2016).

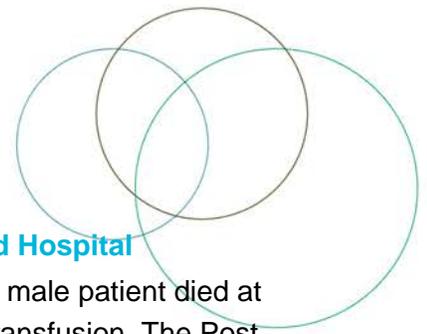
GOAL

Reduce the incidence of complications following infusion, transfusion and therapeutic injection.

IMPORTANCE FOR PATIENTS AND FAMILIES

Patients experiencing acute hemolytic transfusion reactions most often present with fever, chills and hemoglobinuria. Less common symptoms are pain, hypotension, nausea/vomiting, dyspnea, renal failure and disseminated intravascular coagulation (Callum et al., 2016).





Patient Story

Blood on their hands: man dies after transfusion mix-up at Coney Island Hospital

“There’s bad blood at Coney Island Hospital — and it’s deadly. A 40-year-old male patient died at the city-run hospital last week after receiving the wrong type blood during a transfusion, The Post has learned. Transfusions that don’t match a patient’s blood type — giving Type-A to a person who is Type-B, for example — causes the body to attack the new red blood cells, a violent and painful reaction that can lead to shock and a fatal kidney shutdown. “The blood was mislabeled in the lab. It wasn’t a nursing issue,” said one hospital professional who spoke yesterday on condition of anonymity. “It shouldn’t have happened; it’s just carelessness. It’s a huge problem,” he added. A source said the fatal error occurred in the hospital’s sixth-floor lab, where blood drawn from patients is screened and ‘typed’. A technician labeled the patient’s blood as the wrong type, and the patient was given the wrong blood during a transfusion.”

(New York Post, July 14, 2013)

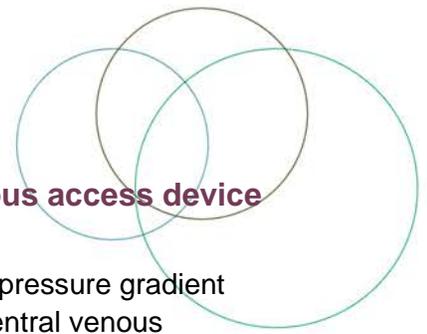
EVIDENCE INFORMED PRACTICE

Prevention of air embolism during/following infusion, transfusion and therapeutic injection

(Feil, 2012; Infusion Nurses Society, 2011a, 2011b)

1. In advance of injection or infusion, fully prime all infusion tubing, and expel air from syringes.
2. Catheters or other tubes inserted into the body should be inserted and removed using a technique that minimizes the possibility of air getting into the blood vessels.
3. During surgical procedures, patients should be closely monitored to help ensure air bubbles do not form in blood vessels.
4. Ensure all arterial and venous catheters and connections are intact and secure.
5. Ensure that all self-sealing valves of arterial and venous catheters are functioning properly.
6. Use infusion pumps with air-in-line sensors for all continuous infusions.
7. Remove air from infusion bags before infusing fluids.
8. Trace lines, double-check all connections, and take all steps necessary to prevent tubing disconnections.
9. Inspect the insertion site, catheter, and all connections regularly to assess for breaks or openings through which air could enter the system.
10. Ensure the integrity of the central line dressing surrounding the skin insertion site.





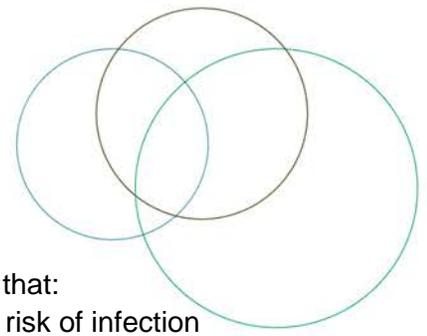
Prevention of air embolism secondary to insertion of central venous access device
(Feil, 2012; Joint Commission, 2010; Mirski et al., 2007)

1. Take steps to increase the central venous pressure, decreasing the pressure gradient that would normally favour movement of air into the bloodstream. Central venous pressure is normally lower in all blood vessels located above the level of the heart and during inspiration.
 - a. Place the patient in the Trendelenburg position with a downward tilt of 10 to 30 degrees during central line placement.
 - b. Avoid insertion during patient inspiration. Instruct the patient to hold his or her breath, and perform a Valsalva maneuver, if able.
 - c. Hydrate the patient to correct hypovolemia prior to insertion whenever possible.
2. Ensure all catheters and connections are intact and secure.
3. Occlude the catheter and/or needle hub.
4. Ensure that all self-sealing valves are functioning properly.

Prevention of air embolism secondary to removal of central venous access device
(Feil, 2012; Joint Commission, 2010; Mirski et al., 2007)

1. Place the patient in the Trendelenburg position. If not possible, place in the fully supine position.
2. Position the catheter exit site (e.g., neck, arm) at a height lower than the patient's heart.
3. Cover the exit site with gauze and hold in place with gentle pressure while removing the catheter in a slow, constant motion.
4. Instruct the patient to hold his or her breath, and perform a Valsalva maneuver as the last portion of the catheter is removed; if the patient is unable to do so, remove during patient's expiration phase.
5. Place pressure on the site until hemostasis is achieved. One to five minutes is suggested.
6. Apply a sterile occlusive dressing, such as gauze impregnated with petroleum jelly and covered with a transparent film dressing. Leave dressing in place for at least 24 hours. Changing every 24 hours until the exit site has healed. Plain gauze dressings have been associated with air passing through a persistent catheter tract into the bloodstream, resulting in air embolisms, as have occlusive dressings left in place for shorter periods of time.
7. Instruct the patient to remain lying flat for 30 minutes after removal of the catheter.





Prevention of phlebitis secondary to intravenous catheterization

(O'Grady et al., 2002)

1. When selecting the site for intravenous catheterization keep in mind that:
 - a. Lower extremity insertion sites are associated with a higher risk of infection than are upper extremity sites.
 - b. Hand veins have a lower risk for phlebitis than veins on the wrist or upper arm.
2. Ensure good hand hygiene before catheter insertion or maintenance. Use proper aseptic technique during catheter manipulation to prevent infection.
3. Consider use of in-line filters to reduce the incidence of infusion-related phlebitis.

Prevention of ABO incompatibility reaction

(Callum et al., 2016)

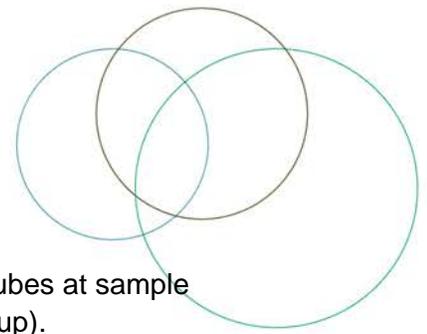
1. Pay meticulous attention to identifying the patient and labelling the tubes at sample collection (to ensure that patient is assigned to the correct blood group).
2. Pay meticulous attention to verifying the patient's identity, by checking their hospital identification band before transfusing.
3. When possible, involve the patient or caregiver in the identification process.

Prevention of Rh incompatibility reaction with pregnant women

(National Heart Lung, and Blood Institute, 2011; Ontario Regional Blood Coordinating Network, 2016).

1. Screen pregnant women to find out if they are Rh-negative.
2. If the father of the infant is Rh-positive, or if his blood type is not known, the mother should be given an injection of Rh Immune Globulin during the second trimester. If the baby is Rh-positive, the mother will receive a second injection of Rh Immune Globulin within a few days of delivery.
3. Ensure that women with Rh-negative blood receive Rh Immune Globulin (eg. RhoGAM or WinRho®):
 - a. During every pregnancy.
 - b. After a miscarriage or termination of pregnancy.
 - c. After prenatal tests such as amniocentesis and chorionic villus biopsy.
 - d. After injury to the abdomen during pregnancy.
 - e. After physical trauma (e.g. motor vehicle accident).
 - f. After placental abruption (bleeding in the uterus).
 - g. After giving birth to a Rh-positive baby.





Rh incompatibility due to a mismatched blood transfusion

(Callum et al., 2016)

1. Pay meticulous attention to identifying the patient and labelling the tubes at sample collection (to ensure that patient is assigned to the correct blood group).
2. Pay meticulous attention to verifying the patient's identity, by checking their hospital identification band before transfusing.
3. When possible involve the patient or caregiver in the identification process.

Anaphylactic shock due to serum: prevention of recurrent anaphylaxis

(Callum et al., 2016)

1. Pre-medicate with intravenous steroids and diphenhydramine.
2. If a patient is found to be IgA-deficient with anti-IgA, the following products are recommended:
 - a. IgA-deficient blood products from IgA deficient blood donors, available from Canadian Blood Services.
 - b. Washed RBCs (2L normal saline in 6 wash cycles) or platelets.

Minor allergic reaction: prevention of recurrent urticaria

(Callum et al., 2016)

These precautionary measures may be used, although their efficacy is unknown:

1. Pre-medicate with diphenhydramine, or other non-drowsy antihistamine and/or corticosteroids.
2. Consider plasma depletion of RBCs or platelets.
3. Consider use of washed RBCs or platelets.

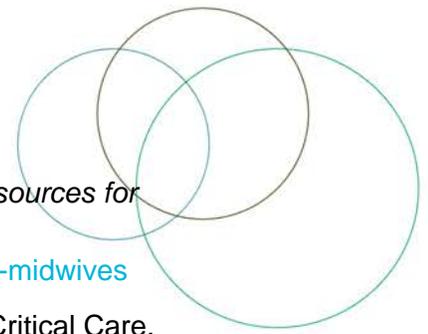
Conduct Clinical and System Reviews (see details below)

Given the broad range of potential causes of complications from infusions, transfusions and injections, in addition to the above recommendations, we recommend conducting clinical and system reviews to identify latent causes and determine appropriate recommendations.

If your review reveals that your cases of complications from infusions, transfusions and injections, are linked to specific processes, procedures or conditions you may find guidelines related to your specific procedure here:

- Canadian Blood Services, Professional Education www.transfusionmedicine.ca
- Ontario Regional Blood Coordinating Network www.transfusionontario.org
 - Callum JL, Pinkerton PH, Lima A, et al. *Bloody Easy 4: Blood transfusions, blood alternatives and transfusion reactions. A guide to transfusion medicine. Fourth Edition.* Ontario Regional Blood Coordinating Network; 2016. http://transfusionontario.org/en/documents/?cat=bloody_easy





- Ontario Regional Blood Coordinating Network (ORBCoN). *Resources for midwives*. ORBCoN; 2016.
<http://transfusionontario.org/en/documents/?cat=resources-for-midwives>
- National Institute for Health and Care Excellence (NICE), Acute and Critical Care, <https://www.nice.org.uk/guidance/service-delivery--organisation-and-staffing/acute-and-critical-care>
- National Institute for Health and Care Excellence (NICE), Hospitals <https://www.nice.org.uk/guidance/settings/hospitals>
- Norfolk D (Ed). *Handbook of Transfusion Medicine, 5th Ed*. United Kingdom Blood Services. 2013. <http://www.transfusionsguidelines.org/transfusion-handbook>

Clinical and System Reviews, Incident Analyses

Occurrences of harm are often complex with many contributing factors. Organizations need to:

1. Measure and monitor the types and frequency of these occurrences.
2. Use appropriate analytical methods to understand the contributing factors.
3. Identify and implement solutions or interventions that are designed to prevent recurrence and reduce risk of harm.
4. Have mechanisms in place to mitigate consequences of harm when it occurs.

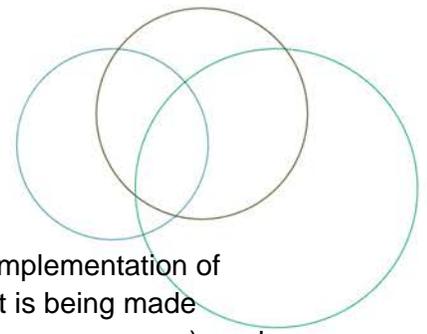
To develop a more in-depth understanding of the care delivered to patients, chart audits, incident analyses and prospective analyses can be helpful in identifying quality improvement opportunities. Links to key resources for analysis methods are included in Resources for Conducting Incident and/or Prospective Analyses section of the Introduction to the Hospital Harm Improvement Resource.

Chart audits are recommended as a means to develop a more in-depth understanding of the care delivered to patients identified by the Hospital Harm measure. Chart audits help identify quality improvement opportunities.

Useful resources for conducting clinical and system reviews:

- [Chart Audit Review Process](#) (see Introduction to the Improvement Resource)
- [Canadian Incident Analysis Framework](#)
- [Canadian Patient Safety Institute Patient Safety and Incident Management Toolkit](#)
- [HIROC Critical Incident & Multi-Patient Events Risk Resource Guide](#)
- [Institute for the Safe Medication Practices Canadian Failure Mode and Effects Analysis Framework](#)
- [Institute for Healthcare Improvement Failure Mode and Effects Analysis Tool](#)





MEASURES

Vital to quality improvement is measurement, and this applies specifically to implementation of interventions. The chosen measures will help to determine whether an impact is being made (primary outcome), whether the intervention is actually being carried out (process measures), and whether any unintended consequences ensue (balancing measures).

Below are some recommended measures to use, as appropriate, to track your progress. In selecting your measures, consider the following:

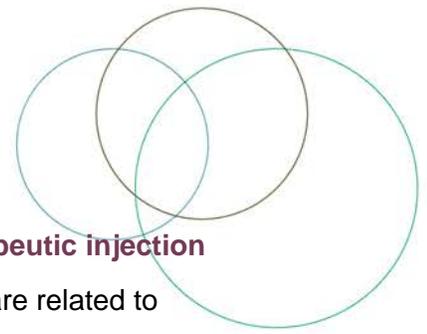
- Whenever possible, use measures you are already collecting for other programs.
- Evaluate your choice of measures in terms of the usefulness of the final results and the resources required to obtain them; try to maximize the former while minimizing the latter.
- Try to include both process and outcome measures in your measurement scheme.
- You may use different measures or modify the measures described below to make them more appropriate and/or useful to your particular setting. However, be aware that modifying measures may limit the comparability of your results to others.
- Posting your measure results within your hospital is a great way to keep your teams motivated and aware of progress. Try to include measures that your team will find meaningful and exciting (IHI, 2012).

For more information on measuring for improvement contact the Canadian Patient Safety Institute Central Measurement Team at measurement@cpsi-icsp.ca

Outcome Measures

1. Per cent of patients with air embolism following infusion, transfusion and/or therapeutic injection.
2. Per cent of patients with phlebitis secondary to intravenous catheterization.
3. Per cent of patients receiving a blood transfusion who have an ABO incompatibility reaction.
4. Per cent of pregnant women who have an Rh incompatibility reaction.
5. Per cent of newborns who have an Rh incompatibility reaction.
6. Percentage of patients receiving a blood transfusion who have an Rh incompatibility due to a mismatched blood.
7. Per cent of patients receiving a blood transfusion who have anaphylaxis due to serum.
8. Per cent of patients receiving a blood transfusion who develop urticaria due to serum.





Process Improvement Measures

Prevention of air embolism following infusion, transfusion and/or therapeutic injection

1. Per cent of patients who receive the following steps for appropriate care related to infusion, transfusions and/or injections:
 - a. Remove all air from syringes and intravenous lines.
 - b. Insert and remove catheters using a technique that minimizes the possibility of air entry to the blood vessels.
 - c. Arterial and venous catheters and connections are intact and secure.
 - d. Self-sealing valves of arterial and venous catheters are functioning properly.
 - e. Use of infusion pumps with air-in-line sensors for all continuous infusions.
 - f. Remove air from infusion bags when infusing fluids.
 - g. Trace lines, double-check all connections, and take all steps necessary to prevent tubing disconnections.
 - h. Inspect on a regularly basis the insertion site, catheter, and all connections to assess for breaks or openings through which air could enter the system.
2. Percentage of patients with a central line who have the integrity of the central line dressing at the skin insertion site assessed.

Prevention of air embolism secondary to insertion of central venous access device

1. Percent of patients who receive the following steps involved in appropriate care related to insertion of central venous access device:
 - a. The patient is placed in the Trendelenburg position with a downward tilt of 10 to 30 degrees during central line placement.
 - b. Insertion while the patient is holding his or her breath.
 - c. Hydrate the patient to correct hypovolemia prior to insertion whenever possible.
 - d. Ensure all catheters and connections are intact and secure.
 - e. Occlude the catheter and/or needle hub.
 - f. Ensure that all self-sealing valves are functioning properly.

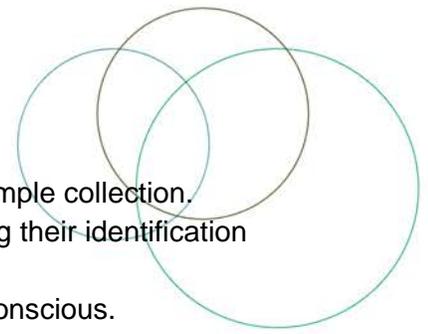
Prevention of phlebitis secondary to intravenous catheterization

1. Per cent of patients who receive the following steps involved in the prevention of phlebitis:
 - a. Appropriate site selection.
 - b. Appropriate hand hygiene before catheter insertion or maintenance.
 - c. Proper aseptic technique during catheter manipulation.
 - d. Use of in-line filters to reduce the incidence of infusion-related phlebitis.

Prevention of ABO incompatibility reaction

1. Per cent of patients who receive the following steps involved in the prevention of ABO incompatibility reaction:





- a. Strict attention to patient identification and tube labelling at sample collection.
- b. Verify the patient's identity and date of birth (DOB) by checking their identification band before transfusing.
- c. Have the patient state their name and date of birth (DOB), if conscious.

Prevention of Rh incompatibility reaction with pregnant women

1. Per cent of pregnant women who receive the following steps involved in the prevention of Rh incompatibility reaction:
 - a. Screen for Rh status.
 - b. If the mother is Rh-negative, screen the father of the infant. If the father is Rh-positive, or if his blood type is not known, the Rh-negative mother is given an injection of Rh Immune Globulin during the second trimester.
 - c. If the baby is Rh-positive, the mother is given a second injection of Rh Immune Globulin within a few days of delivery.

Prevention of Rh incompatibility due to a mismatched blood transfusion

1. Per cent of patients who receive the following steps involved in the prevention of Rh incompatibility due to a mismatched blood transfusion:
 - a. Strict attention to patient identification and tube labelling at sample collection.
 - b. Verify the patient's identity and date of birth (DOB) by checking their identification band before transfusing.
 - c. Have the patient state their name and date of birth (DOB), if conscious.

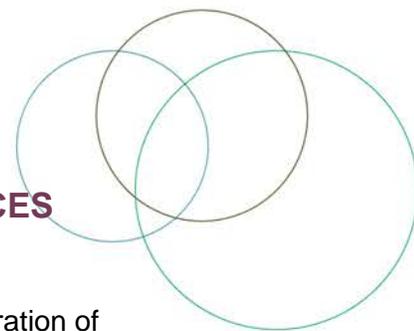
To prevent anaphylactic shock due to serum: prevention of recurrent anaphylaxis

1. Per cent of patients who receive the following steps involved in the prevention of recurrent anaphylaxis:
 - a. Pre-medicate with intravenous steroids and diphenhydramine.
 - b. If a patient is found to be IgA-deficient with anti-IgA, the following products are considered:
 - i. IgA-deficient blood products from IgA deficient blood donors, available from Canadian Blood Services.
 - ii. Washed RBCs (2L normal saline in 6 wash cycles) or platelets.

Minor allergic reaction: prevention of recurrent urticaria

1. Per cent of patients who receive the following steps involved in the prevention of recurrent urticarial:
 - a. Pre-medicate with diphenhydramine, or other non-drowsy antihistamine and/or corticosteroids.
 - b. Consider using plasma depletion of RBCs or platelets.
 - c. Consider using washed RBCs or platelets.





STANDARDS AND REQUIRED ORGANIZATIONAL PRACTICES

Accreditation Canada Standards

Medication Management Standards: Requirements around the safe administration of medications, including staff training, use of alarm systems, methods to prevent medication errors for both staff and clients, and monitoring clients who self-administer medications. Requirements also include content on the safe packaging, labelling, and dispensing of medications.

Transfusion Services Standards: Requirements that the team uses and follows, standard operating procedures (SOPs) for activities including collection, labelling, storing, and transfusion. As well, the standards include requirements to ensure the physical environment and equipment support safe and effective services. The standards also include specific content regarding information to be validated prior to infusion and monitoring of clients for complications during and after infusion.

Cancer Care Standards: Requirements around the safe preparation and administration of systemic therapies including education and training on new medications or regimens, monitoring clients for reactions, care for vascular access devices and infusion sites, and preparing clients for safe home infusion.

Required Organizational Practice

Infusion Pump Safety requires a documented and coordinated approach to infusion pump safety that includes training, evaluation of competence, and a process to report problems with infusion pump use.

GLOBAL PATIENT SAFETY ALERTS

[Global Patient Safety Alerts](#) (GPSA) provides access and the opportunity to learn from other organizations about specific patient safety incidents including alerts, advisories, recommendations and solutions for improving care and preventing incidents. Learning from the experience of other organizations can accelerate improvement.

Recommended search terms:

- Air Embolism
- Blood Products/Transfusion





INFUSION, TRANSFUSION AND INJECTION COMPLICATIONS SUCCESS STORIES

Sunnybrook Health Sciences Centre

Patient blood management has been defined as any intervention that helps decrease the patient's likelihood of needing a blood transfusion during their hospital stay. Fairly liberal transfusion practice for anemic patients was the standard of care throughout the world. However, in the last decade there is evidence of many adverse outcomes associated with blood transfusion, especially when given during or immediately after a surgical intervention.

The greatest predictor of whether a patient will need a transfusion is their preoperative hemoglobin level. The Holland Centre at Sunnybrook performs over 3,000 orthopaedic surgical procedures annually. In 2011, it introduced routine CBC (complete blood count) preoperative screening of all surgical candidates to identify anemic patients, manage potential anemia and refer high risk patients to the Blood Conservation Clinic for anemia optimization before surgery.

All preoperative patients are given oral iron for one month. If patients are anemic, they are referred to the Blood Conservation Clinic (BCC) four to six weeks preoperatively for consideration of IV iron or Eprex. The project involved an interprofessional team that included Anesthesia, Hematology, Nursing, and Orthopaedic Surgeons. A preoperative blood conservation algorithm was designed and broad staff education was conducted. Patient education materials were also developed. Transfusion rates during the study period were 3.6 per cent compared to 5.1 per cent previously. The estimated cost-savings associated with fewer transfusions in this patient population was \$75,000.

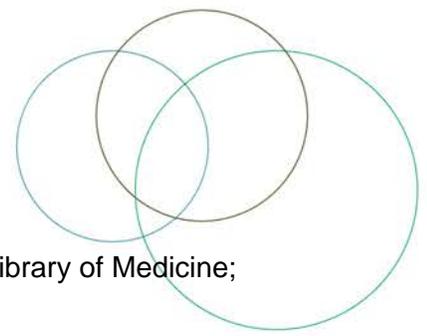
(Accreditation Canada, 2013)

Sainte-Justine UHC, Quebec

With a focus on providing quality care, the Transfusional Medicine Committee at Sainte-Justine UHC put forth a recommendation to introduce transfusion practice certification for all transfusion staff. Thereby, a transfusion practice training and certification program was implemented at Sainte-Justine UHC in 2005. Sainte-Justine is the first hospital centre to have implemented a certification of such calibre. The program seeks to decrease the number of transfusion accidents and promote professional development among nursing staff. Certification applies to nurses, transfusion inhalotherapists, perfusionists and phlebotomists. Licensed Practical Nurses will be included next. With recertification taking place every two years, an internal study was conducted to evaluate the suitability of maintaining this program within the organization.

(Accreditation Canada, 2012)





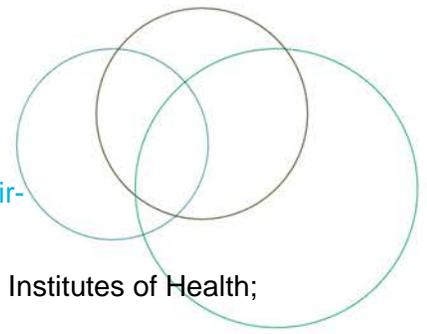
REFERENCES

- Transfusion reaction – hemolytic. *A.D.A.M. Medical Encyclopedia*. National Library of Medicine; 2016. <https://medlineplus.gov/ency/article/001303.htm>
- Accreditation Canada. *Best practice in patient blood management in a surgical patient population*. Accreditation Canada; 2013. <https://accreditation.ca/node/6773>
- Accreditation Canada. *Transfusion practice certificate at Sainte-Justine UHC*. Accreditation Canada; 2012. <https://accreditation.ca/node/6683>
- Callum JL, Pinkerton PH, Lima A, et al. *Bloody Easy 4: Blood transfusions, blood alternatives and transfusion reactions. A guide to transfusion medicine. Fourth Edition*. Ontario Regional Blood Coordinating Network; 2016. http://transfusionontario.org/en/documents/?cat=bloody_easy
- Feil M. Reducing risk of air embolism associated with central venous access devices. *PA Patient Saf Advis*. 2012;9(2):58-64. [http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2012/Jun;9\(2\)/Pages/58.aspx](http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2012/Jun;9(2)/Pages/58.aspx)
- Food and Drug Administration (FDA). *Fatalities reported to FDA following blood collection and transfusion: Annual summary for fiscal year 2009*. FDA; 2012. <http://www.fda.gov/BiologicsBloodVaccines/SafetyAvailability/ReportaProblem/TransfusionDonationFatalities/ucm204763.htm>
- Fung MK, Downes KA, Shulman IA. Transfusion of platelets containing ABO-incompatible plasma: a survey of 3156 North American laboratories. *Arch Pathol Lab Med*. 2007;131(6):909-916. <http://www.archivesofpathology.org/doi/full/10.1043/1543-2165%282007%29131%5B909%3ATOPCAP%5D2.0.CO%3B2>
- Gordy S, Rowell S. Vascular air embolism. *Int J Crit Illn Inj Sci*. 2013;3(1):73-76 doi:10.4103/2229-5151.109428. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3665124/>
- Infusion Nurses Society. Infusion nursing standards of practice. *J Infus Nurs*. 2011a; 34 (1S): S1-S110. <https://engage.ahima.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=2238ee0a-c2df-4d1a-affa-f69f2ce41856>
- Infusion Nurses Society. Infusion-related complications. *Policies and procedures for infusion nursing*, 4th ed. Hagerstown, MD: Lippincott, Williams and Wilkins. 2011b:96-123.
- Institute for Healthcare Improvement (IHI). *How-to Guide: Prevent harm from high-alert medications*. Cambridge, MA: IHI;2012.
- Joint Commission. *Clinical care improvement strategies: Preventing air embolism*. Oakbrook Terrace, IL: Joint Commission Resources; 2010.
- Mirski MA, Lele AV, Fitzsimmons L, Toung TJ. Diagnosis and treatment of vascular air embolism. *Anesthesiology*. 2007; 106 (1): 164-177. <http://anesthesiology.pubs.asahq.org/article.aspx?articleid=1923071>



HOSPITAL HARM IMPROVEMENT RESOURCE

Infusion, Transfusion and Injection Complications



- National Health Service. *Air embolism*. 2015. <http://www.nhs.uk/Conditions/Air-embolism/Pages/Introduction.aspx>
- National Heart, Lung and Blood Institute. *What is Rh Incompatibility?* National Institutes of Health; 2011. <https://www.nhlbi.nih.gov/health/health-topics/topics/rh>
- O'Grady N, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. Centers for disease control and prevention. *MMWR Recomm Rep*. 2002;51(RR-10):1-29. <https://www.cdc.gov/mmwr/PDF/rr/rr5110.pdf>
- Ontario Regional Blood Coordinating Network (ORBCoN). *Resources for midwives*. ORBCoN; 2016. <http://transfusionontario.org/en/documents/?cat=resources-for-midwives>
- Ray-Barruel G, Polit DF, Murfield JE, Rickard CM. Infusion phlebitis assessment measures: a systematic review. *J Eval Clin Pract*. 2014;20(2):191-202doi:10.1111/jep.12107. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4237185/>

INFUSION, TRANSFUSION AND INJECTION COMPLICATIONS RESOURCES

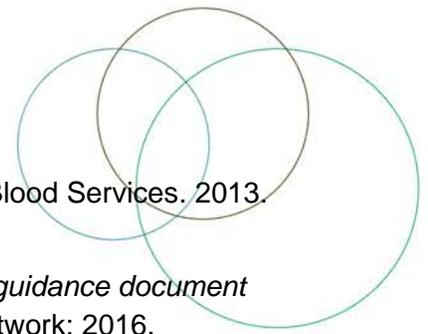
Professional Associations and Helpful Websites

- [Canadian Blood Services](#)
- Choosing Wisely Canada: Transfusion Medicine <http://www.choosingwiselycanada.org/recommendations/transfusion-medicine/>
- [Ontario Regional Blood Coordinating Network](#)
- [National Institute for Health and Care Excellence \(NICE\) \(UK\)](#)

Clinical Practice Guidelines

- Callum JL, Pinkerton PH, Lima A, et al. *Bloody Easy 4: Blood transfusions, blood alternatives and transfusion reactions. A guide to transfusion medicine. Fourth Edition*. Ontario Regional Blood Coordinating Network; 2016. http://transfusionontario.org/en/documents/?cat=bloody_easy
- Clark G., Charge S. (Eds). *Clinical Guide to Transfusion Medicine*. 4th ed. Canadian Blood Services; 2016. <https://professionaleducation.blood.ca/en/transfusion/clinical-guide-transfusion>
- Joint United Kingdom (UK) Blood Transfusion and Tissue Transplantation Services Professional Advisory Committee. *Guidelines*. <http://www.transfusionguidelines.org/>
- National Institute for Health and Care Excellence (NICE). *Blood transfusion: NICE guideline [NG24]*. NICE; 2015. <https://www.nice.org.uk/guidance/ng24/chapter/key-priorities-for-implementation>
- National Institute for Health and Care Excellence (NICE). *Intravenous fluid therapy in adults in hospital: Quality standard [QS66]*. NICE; 2014. <https://www.nice.org.uk/guidance/qs66>





Norfolk D (Ed). *Handbook of Transfusion Medicine, 5th Ed.* United Kingdom Blood Services. 2013.
<http://www.transfusionguidelines.org/transfusion-handbook>

Ontario Transfusion Quality Improvement Plan (OTQIP) Committee. *OTQIP guidance document for institutional implementation.* Ontario Regional Blood Coordinating Network; 2016.
<http://transfusionontario.org/en/wp-content/uploads/sites/4/2016/04/Quality-Improvement-Plan-Guidance-Document-final.pdf>

Registered Nurses' Association of Ontario (RNAO). *Assessment and device selection for vascular access.* Toronto, ON: RNAO; 2008. <http://rnao.ca/bpg/guidelines/assessment-and-device-selection-vascular-access>

Registered Nurses' Association of Ontario. *Care and maintenance to reduce vascular access complications.* Toronto, ON: RNAO; 2008. <http://rnao.ca/bpg/guidelines/care-and-maintenance-reduce-vascular-access-complications>

Additional Resources for Infusion, Transfusion and Injection Complication

Australian Red Cross Blood Service. *Febrile non-haemolytic transfusion reactions (FNHTR).* Australian Red Cross Blood Service; 2016.
http://www.transfusion.com.au/adverse_transfusion_reactions/febrile_non-haemolytic

Brockmeyer J, Simon T, Seery J, Johnson E, Armstrong P. Cerebral air embolism following removal of central venous catheter. *Mil Med.* 2009;174(8):878-881.

Drewett SR. Central venous catheter removal: procedures and rationale. *Br J Nurs.* 2000;9(22):2304-2315.DOI:10.12968/bjon.2000.9.22.5417.

Ingram P, Sinclair L, Edwards T. The safe removal of central venous catheters. *Nurs Stand.* 2006;20(49):42-46.DOI:10.7748/ns2006.08.20.49.42.c4483.

Linden JV, Wagner K, Voytovich AE, Sheehan J. Transfusion errors in New York State: an analysis of 10 years' experience. *Transfusion.* 2000;40(10):1207-1213.

Pennsylvania Patient Safety Authority. Tubing misconnections: making the connection to patient safety. *Pa Patient Saf Advis.* 2010;7(2):41-45.
[http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2010/Jun7\(2\)/Pages/41.aspx](http://patientsafetyauthority.org/ADVISORIES/AdvisoryLibrary/2010/Jun7(2)/Pages/41.aspx)

Perrotta PL, Snyder EL. Non-infectious complications of transfusion therapy. *Blood Rev.* 2001;15(2):69-83.DOI:10.1054/blre.2001.0151.

Pineda AA, Vamvakas EC, Gorden LD, Winters JL, Moore SB. Trends in the incidence of delayed hemolytic transfusion reactions. *Transfusion.* 1999;39(10):1097-1103. Erratum: *Transfusion.* 2000;40(7):891.

Popovsky MA, Audet AM, Andrzejewski C Jr. Transfusion-associated circulatory overload in orthopedic surgery patients: a multi-institutional study. *Immunohematology.* 1996;12(2):87-89.

Schroeder ML. Transfusion-associated graft-versus-host disease. *Brit J Haematol.* 2002;117(2):275-287. <http://onlinelibrary.wiley.com/doi/10.1046/j.1365-2141.2002.03450.x/full>

