Erythrocyte Survival Time

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NOTE: no changes have been made since the version of 2007

1. Introduction

Autological erythrocytes are labelled using ^{51}Cr sodium chromate after which they are intravenously re-injected into the patient. Blood samples are subsequently taken over a period of up to four weeks so the half-life of these labelled erythrocytes can be determined. Using a scintillation detector, organ curves can be made over this period in time for the heart, liver and spleen in order to determine where the erythrocytes are broken down.The method will not be discussed further in this protocol.

2. Methodology

This guideline is based on available scientific literature on the subject, the previous guideline (Aanbevelingen Nucleaire Geneeskunde 2007), international guidelines from EANM and/or SNMMI if available and applicable to the Dutch situation.

3. Indications

a. Suspected haemolytic anaemia that cannot be confirmed using other, simpler techniques.
b. Investigation into the cause of haemolytic anaemia: erythrocyte related factors or external factors.
c. Blood transfusion in patients with antibodies against red blood cells.

4. Relation to other diagnostic procedures

None

5. Medical information necessary for planning

a. Probability diagnosis.
b. Relevant haematological parameters (Hb, Ht, etc.).
c. Weight of patient.

6. Radiopharmaceutical

Preparation:	^{51}Cr autological erythrocytes
Nuclide:	Chromium-51
Dose:	For labelling, 1,4 MBq ^{51}Cr sodium chromate of which approximately 85% is administered
Administration:	Intravenous

7. Radiation safety

a. Pregnancy

Considering the relatively low dose, < 1,5 MBq ^{51}Cr sodium chromate, the benefits of

het diagnostics revenues will quickly outweigh the assumed risk to the unborn child. The estimated dose to the unborn child will be 0,02 mGy for a 1,4 MBq dose. For dosages under 100 mGy no health detriment has been reported for unborn children, therefore a dose less than 0,02 mGy is acceptable.

b. Lactation

Pregnancy is a contraindication. Radiation exposure is about 0,88 mSv for an adult with normal renal function who receives 100 MBq dose According to ICRP 106 there is no need to interrupt breastfeeding, but due to possible free ^{99m}Tc pertechnetate it is advisable to interrupt the feeding for 4 h.

c. Radiation exposure

The effective dose to the patient given 1,4 MBq , will be 0,24 mSv.

8. Patient preparation/essentials for procedure

The patient should lie down for 15 min before the investigation starts (in order to achieve a stable distribution of blood in the body). Then an intravenous cannula is inserted so blood can be withdrawn at the required times without tourniquet pressure.

Requirements

a. A three-way tap allowing the syringe containing the radiopharmaceutical to be flushed three times.
b. Saponin to lyse the whole blood samples.
c. For erythrocyte labelling: a sterile, pyrogen-free 30 ml siliconized vial containing 2,5 ml ACD solution (0,8% citric acid, 2,45% glucose, 2,2% trisodium citrate).

Procedure

a. Withdraw 10 ml of blood from the patient, preferably using a 1,1×40 mm needle (0,8×40 mm may also be used), attach a new needle to the syringe and transfer the blood into ACD solution (see 6c). Gently invert the container several times in order to mix solution.
b. See part III 'Radiopharmacy' section for instructions on processing and labelling blood.
c. The 10 ml labelled ACD blood must be administered as accurately as possible; no extravasation may occur. The use of a three way tap is recommended and the syringe should be flushed three times with a sterile saline solution.
d. Blood must never be taken from the arm into which the radioactive tracer has been administered; blood flow in the arm may not be restricted (e.g. by using a tourniquet) when blood is being collected. Blood samples (approximately 10 ml of heparinised blood) are taken at the following times:

   - In week 1: the first sample is taken 60 min post injection, the second after 24 h and then every other day. Blood samples must be taken every day if a significantly short erythrocyte survival time is suspected.
   - In week 2: two samples are taken
   - In week 3: two samples are taken
   - In week 4: two samples are taken

   It is not necessary to take samples for four weeks in the even t of a decreased erythrocyte half-life. The date and time of sampling must be recorded on each

sample. The samples must be weighed and processed (including determination of haematocrit) on the same day as they are taken.

e. In order to determine the concentration of radioactivity in the erythrocytes present in the blood samples, a correction is made for radioactivity in the blood plasma without any need for these small quantities to be washed. For this purpose, 3 ml of each 10 ml homogenised whole blood sample is pipetted into counting tubes and lysed with saponin. The remaining blood is centrifuged after which 3 ml of plasma from the same p.i. times are transferred to counting tubes. Using the haematocrit, corrections can be made for non-radioactive cells in the blood samples. The samples can also be weighed precisely instead of using a pipette.

f. The blood sample data is plotted on a semi logarithmic scale. This data is visually assessed and corrected for outliers due to errors made during sample withdrawal etc. The resulting curve can be analysed using various methods. The simplest method is to visually determine the time at which the activity in the blood has decreased by 50%. The reference value for this (T_{50}) is 26 to 30 days. The ICSH recommends that both linear and exponential curves are plotted and that the curve with the best fit is used to determine the survival time. If neither the linear nor the exponential curve provides a good fit, a weighted mean method or the Dornhorst function may be used.

   Finally, an elution correction factor can be applied for ^{51}Cr as this label gradually detaches from the erythrocytes. In healthy volunteers, this occurs at a rate of approximately 1% a day. The variance among haematology patients, however, is greater than among healthy volunteers (between 0,5% and 2,5% per day), which makes the correction much less reliable. Elution has the most influence on an erythrocyte survival curve when the survival time is normal. The influence is less when the survival time is significantly decreased.

9. Acquisition and processing

The measurement is carried out using a suitable scintillation counter.

10. Interpretation

a. This method assumes steady-state (i.e. stable) erythrocyte production and breakdown conditions. The measurement will not be reliable if such conditions do not exist, for example following blood loss or blood transfusion.

b. The question as to whether increased haemolysis is due to the erythrocytes themselves or external factors can be answered by comparing the survival times of a patient's own erythrocytes and donor erythrocytes.

11. Report

The report should contain reference values for the analysis method used.

12. Literature

- International Committee for Standardization in Hematology. Recommended methods for radioisotope red-cell survival studies. Brit J Haematol 1971; 21:241-50.
- International Committee for Standardization in Hematology. Recommended methods for measurement of red-cell and plasma volume. J Nucl Med 1980;21:793-800.

- International Committee for Standardization in Hematology. Recommended methods for radioisotope red-cell survival studies. Brit J Haematol 1980;45:659-66.
- Lötter MG, le Rabé WR, de Lange AH, et al. Reference values for red cell survival times. J Nucl Med 1991;32:2245-8.