1.6 Drug and fluid administration

Enteral fluids
- The best method of maintaining caloric intake is through enteral feeding.
- If the patient is unable to drink then pass a gastric tube (see Section 8.5).

When commencing feed by naso- or oro gastric tube:
1. Fill the syringe to the required amount with feed.
2. Draw the plunger back as far as possible.
3. Attach the syringe to the tube.
4. Kink the tube and remove the plunger.
5. Allow feed to pass into the stomach using gravity.
6. Observe the patient’s colour and respiratory rate for any signs of aspiration.
- Breast milk is the best food for infants. It is always available at the correct temperature, no preparation is required, and no sterilising equipment is involved. If the infant is too ill to suck and is fed through a gastric tube, encourage the mother to express milk into a sterile receptacle.
   1. To encourage the release of milk and ease of expression, it may help if the mother expresses milk while holding the baby.
   2. Store excess milk in a refrigerator (<5°C) for up to 5 days or freezer (minus 20°C) for up to 6 months.
   3. Defrost the quantity needed for 4 hours of feeding at a time.
- Oral rehydration solutions are used in gastroenteritis to maintain electrolyte balance. Prepare by adding 1 sachet to 210 mL (7 oz) of clean water. (One ounce = 30 mL.)

Intravenous fluids
Intravenous (IV) fluids must only be used when essential and enteral feeds are not available or not absorbed. Always check the container before use, to ensure that the seal is not broken, the expiry date has not been passed, and the solution is clear and free of visible particles.

Choice of crystalloid fluid
Dextrose/glucose-only fluids
It is clear that although glucose or dextrose is necessary to prevent or manage hypoglycaemia, fluids containing only dextrose which are hypotonic should never be used for IV fluid replacement or maintenance, or for the emergency management of shock.

This is because the dextrose is rapidly metabolised, so the effect of a dextrose-only IV fluid on the child’s body in shock may produce hyponatraemia, which could lead to brain damage or death. In addition, this solution is rapidly moved out of the circulation and into the cells, and the state of shock will not be resolved.

Sodium-containing fluids
The fluid traditionally infused into the circulation for the management of shock has been normal saline (0.9% NaCl). This fluid has increasingly been shown to be dangerous, especially in the sick patient. An infusion of normal saline causes a hyperchloroemic acidosis (a high chloride concentration leading to acidosis) which, in the shocked patient, who is already acidic, causes a deterioration in the health of cells in vital organs even though perfusion of the cells has been improved by the increased circulating volume.

There are sodium-containing alternatives to normal saline which are safer because they approximate more closely to human serum/plasma in content (see Table 1.6.1), although they are slightly more expensive. We recommend the use of either of these alternatives – Ringer-lactate and Hartmann’s solution, which are widely available – for all fluid replacement. Hospitals are advised to change their standard crystalloid from 0.9% (‘normal’) saline to Ringer-lactate or Hartmann’s solution as soon as possible. Not all hospitals will have access to these solutions immediately, so there may sometimes be no alternative but to start fluid replacement with normal saline. However, if more than 20 mL/kg needs to be given, one of the safer alternatives should be used in very sick children if at all possible.

Putting dextrose into Ringer-lactate or Hartmann’s solution
A crystalloid containing approximately 5% dextrose can be obtained by adding 50 mL of 50% dextrose to a 500-mL bag of Ringer-lactate or Hartmann’s solution.

A crystalloid containing approximately 10% dextrose can be obtained by adding 100 mL of 50% dextrose to a 500-mL bag of Ringer-lactate or Hartmann’s solution.

(If it will therefore be necessary to remove 50–100 mL of fluid from the 500-mL bag first.)

Ensure that the above process is performed with a

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Na⁺ (mmol/L)</th>
<th>K⁺ (mmol/L)</th>
<th>Cl⁻ (mmol/L)</th>
<th>Ca²⁺ (mmol/L)</th>
<th>Lactate or bicarbonate (mmol/L)</th>
<th>Osmolarity (mOsmol/L)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human serum</td>
<td>135–145</td>
<td>3.5–5.5</td>
<td>98–106</td>
<td>2.2–2.6</td>
<td>22–30</td>
<td>276–295</td>
<td>7.35–7.45</td>
</tr>
<tr>
<td>Ringer-lactate/Hartmann’s solution</td>
<td>131</td>
<td>5.0</td>
<td>111</td>
<td>2.0</td>
<td>29</td>
<td>279</td>
<td>6.0</td>
</tr>
<tr>
<td>0.9% normal saline</td>
<td>154</td>
<td>0</td>
<td>154</td>
<td>0</td>
<td>0</td>
<td>310</td>
<td>5.4</td>
</tr>
</tbody>
</table>
sterile no-touch technique, swabbing the entry point to the bag with an alcohol swab.

Dextrose/glucose solutions that are not in Ringer-lactate or Hartmann’s solution are dangerous for replacing fluid losses.

Never infuse plain water IV: this causes haemolysis and will be fatal.

Always specify the concentrations of dextrose and saline solution to be infused.

Maintenance requirement of electrolytes

Daily sodium and potassium requirements in IV fluids:
- sodium (Na\(^+\)): 3–4 mmol/kg/24 hours in children; 150 mmol/24 hours in pregnancy
- potassium (K\(^+\)): 2–3 mmol/kg/24 hours in children; 100 mmol/24 hours in pregnancy

Crystalloids containing a similar concentration of sodium to plasma (Ringer-lactate or Hartmann’s solution) are used to replace vascular compartment losses. When infused IV, only around 25% remains inside the vascular compartment; the rest passes into the extracellular space.

All fluids should be prepared and administered using an aseptic technique. It is important to observe the cannula site directly (by removing the dressing) for redness and swelling before each IV injection. Observe the patient for pain or discomfort at the IV site. If there are any signs of inflammation, stop all fluids, reassess the need for continuing IV fluid drugs, and resite the cannula if necessary.

The rate of administration of fluids can be calculated in drops per minute as follows:
- In a standard giving set with a drop factor of 20 drops = 1 mL, then mL/hour divided by 3 = drops/minute.
- Record that rate of fluid intake per hour on a fluid balance chart.
- Ensure that the IV site is kept clean.
- Flush the cannula with 0.9% saline or Ringer-lactate or Hartmann’s solution 4-hourly if continuous fluids are not being given.

Prescribing practice and minimising drug errors

Introduction
- Oral administration is safer and less expensive, if it is tolerated and if the condition is not life-threatening.
- The following antibiotics are as effective when given orally as when administered intravenously, although initial IV doses will increase the blood levels more quickly:
  - amoxicillin, ampicillin, chloramphenicol, ciprofloxacin, co-trimoxazole, erythromycin, flucloxacin, fluconazole, metronidazole, sodium fusidate.
- If a drug is given down an orogastric or nasogastric tube, flush the tube through afterwards so that the drug does not remain in the tube.
- Rectally administered drugs are less reliably absorbed than those given orally.
- Liquid formulations are better than suppositories for rectal administration of drugs in infants.

Prescribing
- Use approved names.
- Dosages should be in grams (g), milligrams (mg) or micrograms. Always write micrograms in full. Volumes should be in millilitres (mL).
- Avoid using numbers with decimal points if at all possible (e.g. write 500 mg, not 0.5 g). If decimal points are used, they should be preceded by a zero (e.g. write 0.5 mL, not .5 mL).
- Write times using the 24-hour clock.
- Routes of administration can be abbreviated to IV (intravenous), IM (intramuscular), PO (orally), SC (sub-cutaneous), NEB (nebuliser) and PR (rectally).
- ‘As-required’ prescriptions must be specific with regard to how much, how often and for what purpose the drug is being given (also indicate the maximum 24-hour dose).
- ‘Stop dates’ for short-course treatments should be recorded when the drug is first prescribed.

Measuring drug doses
- Multiple sampling from drug vials increases the risk of introducing infection, as the vials do not contain preservatives or antiseptic.
- Dilute drugs so that volumes can accurately be measured. For example do not use doses of less than 0.1 mL for a 1-mL syringe without diluting sufficiently for you to be able to give an accurate amount of the drug.
- Do not forget to consider the dead space in the hub of the syringe for small volumes.
- For dilutions of more than 10-fold, use a small syringe to inject the active drug, connected by a sterile three-way tap to a larger syringe, and then add diluent to the large syringe to obtain the desired volume.

Delivery
- All IV solutions, including drugs, must be given aseptically.
- Give IV drugs slowly in all cases.
- After injecting into the line (e.g. through a three-way tap), use the usual rate of the IV infusion to drive the drug slowly into the patient.
- If there is no ongoing infusion, give sufficient follow-up (flush) of 0.9% saline, Ringer-lactate or Hartmann’s solution or 5% dextrose to clear the drug from the cannula or T-piece.
- Repeat flushes of 0.9% saline can result in excess sodium intake in infants, so use Ringer-lactate or Hartmann’s solution if possible.
- Flush over a period of 2 minutes to avoid a sudden surge of drug (remember the hub).

Infusions
- These must be given aseptically.
- Adjust the total 24-hour IV fluid intake so that additional infusions for drugs do not alter the total fluid volume.
- Never put more drug or background IV into the syringe or burette than is needed over a defined period of time.
- Check and chart the rate of infusion, and confirm this by examining the amount left every hour.
- Use a cannula, not butterfly needles, for infusions if available.
- Do not mix incompatible fluids IV.
- Do not add drugs to any line containing blood or blood products.
- Infusions of glucose higher than 10%, calcium salts and adrenaline, can cause tissue damage if they leak outside the vein.
- Most IV drugs can be given into an infusion containing...
0.9% saline, Ringer-lactate or Hartmann’s solution or up to 10% glucose (the exceptions include phenytoin and erythromycin).

- If you are using only one line, wait 10 minutes between each drug infused, or separate the drugs by infusing 1 mL of 0.9% saline or Ringer-lactate or Hartmann’s solution.

**Safe IV infusions when no burettes are available**

- Mark the infusion bottle with tape for each hour of fluid to be given, and label each hour.
- Empty the infusion bottle until only the exact amount of fluid to be given is left in the bottle.

**Intravenous lines**

**Placement of the line**

- Always place the cannula aseptically and keep the site clean.
- Use sterile bungs, not syringes, for closing off cannula/butterfly needles between IV injections.

**Care of the line**

- Change the giving set every 3 or 4 days.
- Change the giving set after blood transfusion, or if a column of blood has entered the infusion tubing from the vein, as this will be a site of potential bacterial colonisation.
- Always inspect the site of the cannula tip before and during drug injection. Never give a drug into a drip that has started to tissue. Severe scarring can occur, for example, from calcium solutions.
- Always use luer lock connections to minimise extravasation.

**Sampling from the line**

- Clear the dead space first (by three times its volume).
- Glucose levels cannot be accurately measured from any line through which a glucose solution is infused.
- Blood cultures should always be taken from a separate fresh venous needle or stab sample.
- After sampling, flush the line. *Remember that repeat flushes of 0.9% saline can result in excess sodium intake in infants.*

**Complications**

**Infection**

- Local infection can become systemic, especially in neonates or the immunosuppressed (e.g. HIV-infected patients).
- If there is erythema in the tissue, remove the cannula.
- If lymphangitis is present, remove the cannula, take a blood culture from a separate vein and start IV antibiotics.

**Air embolism**

- Umbilical or other central venous lines are particularly high risk.
- Another source of air embolus is through the giving set, especially when infusion pumps are used. *Infusion pumps must not be used if there are not enough nurses to closely monitor the infusion.*
- Always use a tap or syringe on the catheter, especially during insertion.

- If air reaches the heart it can block the circulation and cause death.

**Haemorrhage**

- In neonates this can occur from the umbilical stump.
- All connections must be luer locked.
- The connections to the cannula and its entry must be visualised at all times.

**Minimising errors with IV infusions**

- Prescribe or change infusion rates as infrequently as possible.
- Always have the minimum possible number of IV infusions running at the same time.
- Use a burette in which no more than the prescribed volume is present (especially in infants and young children, or with drugs such as quinine or magnesium sulphate in pregnancy).
- Record hourly the amount given (from the burette, syringe or infusion bag) and the amount left.
- Check the infusion site hourly to ensure that fluid has not leaked outside the vein.
- Ensure that flushes are only used if they are essential, and are given slowly over a period of at least 2 minutes.
- Be careful with potassium solutions given IV (use the enteral route when possible).
- Check and double check the following:
  - Is it the right drug? Check the ampoule as well as the box.
  - Is it at the right concentration?
  - Is the shelf life within the expiry date?
  - Has the drug been constituted and diluted correctly?
  - Is it being given to the right patient?
  - Is the dose correct? (Ideally two healthcare workers should check the prescription chart.)
  - Is it the correct syringe? (Deal with one patient at a time.)
  - Is the IV line patent?
  - Is a separate flush needed? If so, has the flush been checked?
  - Are sharps disposed of (including glass ampoules)?
  - Has it been signed off as completed (ideally countersigned)?
  - If the drug has not been received, is the reason stated?

**Intramuscular (IM) injections**

- IM injections are unsafe for patients in shock, especially opiates, where a high dose can be released once recovery of the circulation occurs.
- To avoid nerve damage, only the anterior aspect of the quadriceps muscle in the thigh is safe in infants.
- Use alternate legs if multiple injections are needed.
- Do not give IM injections if a bleeding tendency is present.
- **Draw back the plunger to ensure that the needle is not in a vein before injecting** (especially if administering adrenaline or lidocaine).

In very resource-limited situations, the IM route might be preferred because the drug may reach the patient sooner than if the patient had to wait in a queue to have an IV line sited. It also requires less nursing time and is less expensive;
venous cannulae are often in short supply. The IM route is as effective as the IV route in many situations.

**Storage of drugs**

Hospitals have struggled for many years to ensure that appropriate medicines are available when needed, while at the same time avoiding the problems of controlling the abuse and illegal use of these substances. Medicines that are of most concern in this respect are narcotics and sedatives. Supplies of these drugs must be available for the treatment of acutely ill patients, at the point of admission, in high-dependency care and post-surgical areas, and in all areas involved in the care of patients with terminal illness. Tragically, many care settings have solved the problem of storage by refusing to have stocks of these drugs readily available, either in the belief that patients, especially children, due to their physiological immaturity, do not feel pain, or due to fear of abuse by the patients and their families or healthcare staff.

The responsibility for the safe custody and storage of all medicines and drugs on a ward or department is that of the nurse in charge at any one time. Designated cupboards for the different types of drugs should be available. All cupboards, which should be permanently fixed to an inside wall, should have secure locks that make them inaccessible to unauthorised staff and visitors. Drug cupboards should be kept locked at all times, the keys being the responsibility of the nurse in charge.

Correct storage of drugs is paramount for prolonging the shelf life of the drug, as well as for complying with safety and legal requirements.

Due to the shelf life of some drugs, they need to be stored in a refrigerator, with the temperature set to store the drugs at between 2°C and 8°C. Drugs that need to be stored under these conditions include the following:

- reconstituted oral antibiotics
- eye drops
- rectal paracetamol
- some vaccines
- insulin (although this can be stored for up to 1 month at room temperature)
- oral midazolam
- pancuronium/vancuronium
- ergometrine
- oxytocin.

**Calculating and giving the correct dose**

Children should be weighed naked and their weight (in kg) recorded on the prescription chart. The use of a drug formulary should be considered when calculating the therapeutic dose. To ensure that the correct amount of drug is given from the stock bottle or vial, the following calculation should be used:

\[
\text{prescribed dose divided by concentration of the stock solution} \times \text{(volume of stock dose)}. 
\]

For example, 125 mg (the amount prescribed) divided by 250 mg/5 mL (concentration of the stock solution) \(\times 5\) mL (volume of stock dose)  
\[
\frac{125}{250} \times 5\, \text{mL} = 2.5\, \text{mL}. 
\]

So the amount given would be 2.5 mL.

Medical staff should change the prescribed dose if after using the above calculation the dose is not easily measurable (e.g. 1.33 mL, 2.46 mL). To ensure that the calculated dose is given accurately, a pre-marked syringe should be used. The smaller the required dose, the smaller the syringe that should be used, as it will give a more accurate measurement (i.e. a 1- or 2-mL syringe should be used, not a 10-mL syringe).

Other forms of measurement can be used for larger doses, such as 5 or 10 mL. These include a pre-measured medicine pot or a 5-mL pre-measured medicine spoon. For safety, the calculation should ideally be done by two trained nurses, and the amount dispensed checked by the same two nurses. Although it is recognised in some hospitals that one trained nurse can check oral medication on their own, ideally IV and IM drugs should be checked by two trained nurses or a nurse and a doctor.

**Safe use of morphine in hospital**

Narcotic drugs, which may be controlled by law within the country concerned, should have a separate cupboard permanently fixed to the wall and locked. The keys to drug cupboards should be kept separately to all other keys and be carried by a qualified nurse for the period of each shift, and then handed over to the nurse taking over the next shift.

A logbook is necessary for recording the ordering and use of narcotic drugs. It is completed to order stocks, using one page for each order. It also records the use of each ampoule, tablet or dose of liquid. The name of the patient, hospital identification, date and time when the drug was given, and whether or not any portion of the drug was discarded is entered in the register (see Figure 1.6.1). Then each entry is signed by two staff members. Ideally, both must hold a nursing, medical or pharmacology qualification, and one must be a member of the ward or unit staff.

In addition, two members of unit staff must check the stock levels once in every 24-hour period and sign to confirm that the stocks are correct. Any discrepancy must be reported immediately to the senior nurse manager for the hospital.

Each hospital should have a policy for dealing with unauthorised use of narcotic drugs, and in some countries this will involve national law enforcement agencies.

When new drug stocks are required, the order book is sent to the central pharmacy, ideally in a container with a tamper-proof seal. Once the pharmacist has placed the order in the container, it is sealed and must not be opened until its arrival in the receiving ward or department.

When the stock arrives in the unit, the seal is broken in the presence of the messenger and the contents are checked against the order book, which is then signed by both. Drugs are then entered in the drug register, with two staff members checking and signing. The drugs are placed in the appropriate cupboard, which is then relocked.

In most hospital wards and units, these precautions will both ensure that adequate narcotic drugs are available when they are needed by patients, and prevent provision of supplies to those who may abuse them.

**Use of morphine**

- Morphine is a safe drug if administered by doctors and nurses who know how to use it and how to monitor patients who have been given it. It is not addictive if used only in the short term for severe pain.
It is not difficult to use, but because it is a controlled drug it requires special procedures to ensure its security.

- It is relatively inexpensive.
- It is a powerful and effective drug that is recommended by the WHO as the first-line medication for the treatment and prevention of severe pain.

**Special procedures required to ensure the secure and appropriate use of morphine**

1. Morphine must be stored in a secure locked box attached to the wall of each ward/area where it might be needed.
2. The box must always contain sufficient quantities for any anticipated clinical need.
3. The keys to the box must be readily available to staff who are caring for patients, and held by the senior person on the ward 24 hours a day.
4. A logbook recording every individual dose given and the name of the patient to whom it was administered must be signed by two members of staff.
5. Any unused morphine must be safely disposed of.
6. Every vial must be accounted for and the vials counted to check that the number tallies with the logbook at the beginning of each shift.

Morphine is usually available in 1- or 2-mL ampoules at a concentration of 10 mg/mL. **Always check the strength.**

The dose is 10 mg IV for pregnant women (5 mg initially and then another 5 mg after 5 minutes if necessary).

The dose is 200 micrograms/kg IV for children (100 micrograms/kg initially and then another 100 micrograms/kg after 15 minutes if necessary). **Two people must check the calculation.**

The volume is small, so dilute with 0.9% saline or 5% dextrose up to 10mL.

**Check the dilution.**

The prescription of morphine must be clearly written, dated and signed (do not use fractions for doses). The antidote, naloxone, must also be kept in the secure box.

The patient’s notes must record the prescription and use of morphine.

All patients who are receiving morphine need regular monitoring and charting of ABC in particular:
- respiratory rate
- blood pressure
- oxygen saturation
- AVPU score.

Oxygen and a bag-valve-mask system of appropriate size must be available near to every patient who is receiving morphine.

An example of a page of a controlled drugs record book, such as would be used for morphine, is shown in Figure 1.6.1.

**Summary**

- Morphine is an essential drug that must be used when severe pain is present or likely to occur.
- To ensure its safe use, attention to the logistics of secure storage is of paramount importance.
- Close monitoring of ABC and D (disability) is essential, and naloxone must be available at all times.
- The prescribing and recording of doses of morphine and naloxone must be carefully undertaken.