NHS Greater Glasgow and Clyde

CLINICAL GUIDELINE

Amikacin Dosing Guidelines in Adults ≥ 16 years

A guideline is intended to assist healthcare professionals in the choice of disease-specific treatments.

Clinical judgement should be exercised on the applicability of any guideline, influenced by individual patient characteristics. Clinicians should be mindful of the potential for harmful polypharmacy and increased susceptibility to adverse drug reactions in patients with multiple morbidities or frailty.

If, after discussion with the patient or carer, there are good reasons for not following a guideline, it is good practice to record these and communicate them to others involved in the care of the patient.

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Important Note:

The online version of this document is the only version that is maintained.
Any printed copies should therefore be viewed as 'Uncontrolled' and as such, may not necessarily contain the latest updates and amendments.

NHS GGC Amikacin Dosing Guidelines in Adults ≥ 16 years

This guideline covers dosage regimens for two different IV Amikacin indications. Ensure you choose the correct one for your patient:

1. **Management of *Gram-negative* infections**
2. **Management of Mycobacterial (Tuberculosis & Non-tuberculosis) infections**

These guidelines do not apply to:

- Patients treated in renal units or receiving haemodialysis or haemofiltration
- Major burns
- Ascites
- Cystic fibrosis

Contraindications and Cautions

Contraindications:

- Known allergy to amikacin or any other aminoglycoside.
- Known/ suspected myasthenia gravis (aminoglycosides may impair neuromuscular transmission).
- Known/ family history of mitochondrial DNA mutation m.1555A>G.
- Avoid in decompensated liver disease (jaundice, ascites, encephalopathy, variceal bleeding or hepatorenal syndrome).

Cautions:

- Co-administration with neurotoxic or nephrotoxic agents, e.g. neuromuscular blockers, nonsteroidal anti-inflammatory drugs, ACE Inhibitors; potent diuretics (i.e. IV diuretics, PO furosemide >80mg/daily, PO bumetanide >2mg/day, combination diuretics in refractory oedema e.g. furosemide + metolazone).
- Use with caution in patients with known muscular weakness.
- Chronic Kidney Disease Stage 4/5, ≥ 50% increase in serum creatinine or oliguria for > 6 hours in the past 48 hours:
    - If amikacin is clinically indicated, give one dose as per guidance and check with pharmacy before giving a second dose.
- Patients with hearing loss (avoid if known/suspected mitochondrial DNA mutation).
- If the duration of amikacin is likely to be > 7 days, or repeated courses may be required, refer for genetic testing for m.1555A>G mutation which may increase risk of developing ototoxicity. Please refer via Trakcare selecting the '(Genetics) Germline molecular genetic analysis or storage' pathway.

Prescribing and Monitoring

Amikacin should be prescribed on both HEPMA and on the amikacin prescribing, administration and monitoring (PAM) chart (see Appendix 1).

HEPMA:

- See guideline; Intravenous gentamicin and vancomycin for adults on HEPMA: FAQs.
- Go to 'Add drug' and select 'Amikacin Intravenous Intermittent Infusion'.
- Intravenous amikacin must be prescribed PRN in HEPMA. The dose should be left as the prepopulated '1 dose' and no dose timings should be added to HEPMA. This is to allow for flexibility if the dose or dosage time requires to be altered.
- It is important to alert the nursing staff who are administering the medication that a dose has been prescribed to ensure prompt administration.
- It is good practice to add an 'order note' in HEPMA to alert nursing staff to the IV amikacin prescription and to minimise the risk of missed doses. A box can be ticked when adding the note to 'Suppress on Order Stop/ discontinue' so that when the drug is discontinued, the note will also be removed.

Prescribing, Administration and Monitoring (PAM) chart:

- Intravenous amikacin must also be prescribed on the amikacin PAM chart (see Appendix 1). All information used to calculate an amikacin dose must be documented on the PAM chart. The calculated amikacin dose and frequency must also be prescribed on the PAM chart.
- Prescribe each amikacin dose, as per dosing table below, on the amikacin PAM chart, specifying the date and time the dose should be given. Do not prescribe > 24 hours in advance.
- All relevant toxicity checks should be performed prior to administering each amikacin dose.
- If a patient's dosing schedule is 48 hourly, then write the date and "no dose required – 48 hourly dosing" on the amikacin prescribing, administration and monitoring (PAM) chart on the date(s) that NO amikacin dose is due (see guideline; IV Gentamicin for adults - 48 hourly prescribing and other alternative dosing schedules).
- Once an amikacin dose has been administered it must be documented on both HEPMA and on the PAM chart.
- Upon discontinuation of therapy, ensure the amikacin prescription is stopped on both HEPMA and the PAM chart.

Patients on gender affirming therapy:

- Following ≥ 6 months of hormonal gender affirming therapy, or at any time after completion of gender affirming surgery, calculate Creatinine Clearance (CrCl) and Ideal Body Weight (IBW) according to the patient's gender identity.
- If gender affirming therapy does not meet the criteria above use the patient's sex at birth according to their electronic clinical records. The second last digit of a CHI number informs of a patient's assigned sex at birth; for those assigned male it is odd and for those assigned female it is even

1 NHS GGC Amikacin Dosing Guidelines for the Management of *Gram-negative* infections in Adults ≥ 16 years

Step 1: Initial Amikacin Dosage Guidelines

- **DO NOT use eGFR.** Calculate the creatinine clearance (CrCl) using the NHS GGC CrCl calculator available on StaffNet/ NHS GGC Clinical Guideline Platform or the NHS GGC Adult Therapeutics Handbook App.
- Calculate the amikacin dose using the dosing table below. **Use actual body weight unless BMI > 30 kg/m^2 where adjusted body weight is recommended**:

BMI	weight (kg) / (height (m))^2
Adjusted body weight	IBW + (0.4 x (actual body weight – IBW))
IBW	IBW (kg) = 2.3 kg for every inch above 5 feet (or 2.5 cm above 152 cm) + 45.5 kg (female) or 50 kg (male)

BMI (body mass index), IBW (ideal body weight)

Amikacin dosing table for the Management of *Gram negative* bacteria (see Guideline 2 for Mycobacterial infections)**:**

Creatinine Clearance (CrCl ml/min)*	**Amikacin dose** (use actual body weight or if BMI > 30 kg/m^2 use adjusted body weight)	**Dose frequency**	**Administration**
< 20	2.5 mg/kg (max 200 mg)	Re-dose once trough concentration <5mg/L	IV infusion over 30 mins
20 – 29	5.5 mg/kg (max 550mg)	24 hourly	IV infusion over 30 mins
30 – 49	6 mg/kg (max 600mg)	24 hourly	IV infusion over 30 mins
50 – 70	12 mg/kg (max 1200mg)	24 hourly	IV infusion over 30 mins
> 70	15 mg/kg (max 1500mg)	24 hourly	IV infusion over 30 mins

- If creatinine is not known give 7.5 mg/kg amikacin (maximum 600 mg) and seek advice from pharmacy.
- Administer each amikacin dose as an intravenous infusion in 100 ml sodium chloride 0.9 % over 30 minutes.

Step 2: Monitoring and interpretation of Amikacin concentrations

- Check creatinine daily and record the results on the amikacin PAM chart. Seek advice from pharmacy if renal function is unstable (e.g. a change in creatinine of > 15 – 20 %).

- Amikacin concentrations measurements are essential to guide ongoing therapy, clinical efficacy and possible toxicity. See table below for target amikacin concentrations. Seek advice from pharmacy if you are unsure how to interpret the results or if the concentrations are not within the target ranges below.
    - Take a 'peak' amikacin concentration 1 hour after the end of the first amikacin infusion. Ensure 1 hour has elapsed, from the END of the infusion, as early concentrations will be invalid.
    - Take a 'trough' amikacin concentration at the end of dosage interval (prior to the next dose). Do not delay giving the second amikacin dose while waiting for the trough concentration to be reported, unless there are concerns over deteriorating renal function or CKD 4/5, CrCl < 30 ml/min.
    - Ensure all samples for amikacin analysis, out with Mon - Fri 9 am - 5 pm, are sent directly to the QEUH Biochemistry Department otherwise these will not be processed until the next working day.

Target amikacin 'peak' and 'trough' concentrations:

Creatinine Clearance (CrCl ml/min)	**Target peak concentration** (1 hour post end of infusion)	**Target trough concentration** (end of dosage interval)
≥ 50	> 35 mg/L	< 2.3 mg/L
< 50	15 – 30 mg/L	< 5 mg/L

- Record the exact time of all amikacin samples on the amikacin PAM chart. Ensure all TrakCare sample request forms are printed at the same time of sample collection to ensure accurate sample times are recorded on TrakCare and Clinical Portal.
- Once satisfactory 'peak' and 'trough' concentrations are achieved and if renal function remains stable, check amikacin trough concentrations only every 2 days.
- Seek advice from pharmacy if necessary, e.g.:
    - renal function deteriorates or improves significantly (e.g. a change in creatinine of > 15 – 20%) during amikacin therapy
    - amikacin concentration is unexpectedly high or low

Step 3: Assess daily the ongoing need for amikacin and for signs of toxicity Amikacin can cause nephrotoxicity and ototoxicity (cochlear and vestibular). The risk of amikacin toxicity increases with increasing duration of therapy and may occur irrespective of amikacin concentration.

Nephrotoxicity:

- Signs of amikacin nephrotoxicity include; reduced urine output/ oliguria or increased creatinine.
- Consider an alternative antimicrobial agent if creatinine is increasing or the patient becomes oliguric.

Oto/vestibular toxicity:

- Signs of amikacin **oto/ vestibular toxicity** include: new tinnitus, dizziness, poor balance, hearing loss, oscillating vision.
- Patients should be advised to report signs of ototoxicity (see Patient Information Leaflet, Appendix 2) and they should be asked about any signs and symptoms of ototoxicity regularly. This discussion should be documented in the patient's clinical notes. If ototoxicity is suspected, stop amikacin therapy immediately and discuss with an infection specialist.
- If amikacin continues for >5 days, suggest referral to audiology for assessment.
- The mitrochondrial DNA mutation m.1555A>G predisposes to severe hearing loss following aminoglycoside exposure. Consider the need for genetic testing, especially in patients requiring recurrent or long-term treatment with aminoglycosides (e.g. complex drug resistant infections including tuberculosis, cystic fibrosis or recurrent neutropenic sepsis) but DO NOT delay urgent treatment in order to test. Results can take up to 28 days to be reported. If required, please refer via Trakcare selecting the '(Genetics) Germline molecular genetic analysis or storage' pathway.

Step 4: Duration of amikacin therapy

An Infection specialist should be consulted to advise on the duration and ongoing management of ALL patients prescribed amikacin. If samples sent to microbiology check culture and sensitivities and refer to IV to Oral switch policy.

Step 5: Amikacin Patient Information Leaflet

The prescriber should issue the NHS GGC amikacin patient information leaflet (PIL, see Appendix 2) to the patient/ carer at the earliest opportunity, unless this is considered inappropriate. Any reason for non-issue of the amikacin PIL should be recorded on the amikacin PAM chart.

2 NHS GGC Amikacin Dosing Guidelines for the Management of Mycobacterial (Tuberculosis and Non-tuberculosis) Infections in Adults ≥ 16 years

Step 1: Initial Dosage Guidelines

- **DO NOT use eGFR.** Calculate the creatinine clearance (CrCl) using the NHS GGC CrCl calculator available on StaffNet/ NHS GGC Clinical Guideline Platform or the NHS GGC Adult Therapeutics Handbook App.
- Calculate the amikacin dose using the dosing table below. **Use actual body weight (ABW) unless ABW > ideal body weight where adjusted body weight is recommended.**

Adjusted body weight	IBW + (0.4 x (actual body weight – IBW))
IBW	IBW (kg) = 2.3 kg for every inch above 5 feet (or 2.5 cm above 152 cm) + 45.5 kg (female) or 50 kg (male)

IBW (ideal body weight)

Amikacin dosing table for the Management of Mycobacterial infections (see Guideline 1 for *Gram negative* bacterial infections)**:**

Once daily dosage regimen											
Weight (kg)	**<40**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75-79**	**80-89**	**≥90**
Dose (mg)	550	650	700	800	850	950	1000	1100	1150	1250	1350
CrCl ≥50 ml/min	24 hourly										
CrCl 30-50 ml/min	48 hourly										
CrCl <30 ml/min	Sample at 48 hours and re-dose if concentration < 2.3 mg/L										
Thrice/ twice weekly dosage regimen											
Weight (kg)	**<40**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75-79**	**80-89**	**≥90**
Dose (mg)	900	1000	1200	1300	1400	1600	1700	1800	1900	2000	2200
CrCl ≥50 ml/min	3 x weekly (e.g. Monday, Wednesday, Friday)										
CrCl 30-50 ml/min	Twice weekly (e.g. Monday, Thursday)										
CrCl <30 ml/min	Check concentration at 72 hours and re-dose once concentration < 2.3 mg/L										

- Administer each amikacin dose as an intravenous infusion in 100 ml sodium chloride 0.9 % over 30 minutes.

Step 2: Monitoring of Amikacin Concentrations

- Check creatinine daily and record the results on the amikacin PAM chart. Seek advice from pharmacy if renal function is unstable (e.g. a change in creatinine of > 15 – 20 %).
- Amikacin concentrations measurements are essential to guide ongoing therapy, clinical efficacy and toxicity. See table below for target amikacin concentrations. Seek advice from pharmacy if you are unsure how to interpret the results or if the concentrations are not within the target range:
  - Take a 'peak' amikacin concentration 1 hour after the end of the first amikacin infusion. Ensure 1 hour has elapsed, from the end of the infusion, as early concentrations will be invalid.
  - Take a 'trough' amikacin concentration at the end of dosage interval (prior to the next dose). Do not delay giving the second amikacin dose while waiting for the trough concentration to be reported, unless there are concerns over deteriorating renal function or CrCl < 30 ml/min.
  - If the amikacin trough concentration is higher than the target concentration below (see table) and a further dose has already been administered, repeat the trough concentration measurement and await the result before re-dosing. DO NOT give a further dose until the amikacin concentration is within target range.
  - Ensure all samples for amikacin analysis, out with Mon - Fri 9 am - 5 pm, are sent directly to the QEUH Biochemistry Department otherwise these will not be processed until the next working day.

Target amikacin 'peak' and 'trough' concentrations:

Dosage regimen	**Target peak concentration** (1 hour post end of infusion)	**Target trough concentration** (end of dosage interval)
Once daily	25 – 40 mg/L	< 5 mg/L at 24 hrs
Three times weekly	45 – 65 mg/L	< 2.3 mg/L at 48 hrs
Twice weekly	45 – 65 mg/L	< 2.3 mg/L at 72 hrs

- Record the exact time of all amikacin samples on the amikacin PAM chart. Ensure all TrakCare sample request forms are printed at the same time of sample collection to ensure an accurate sample times are recorded on TrakCare and Clinical Portal.
- Once satisfactory 'peak' and 'trough' concentrations are achieved and if renal function remains stable, check amikacin trough concentrations twice weekly as an inpatient or once weekly if attending as an outpatient.
- Seek advice from pharmacy if necessary, e.g.:
  - renal function deteriorates or improves significantly (e.g. a change in creatinine of > 15 – 20 %) during amikacin therapy
  - amikacin concentration is unexpectedly high or low

Step 3: Assess daily the ongoing need for amikacin and for signs of toxicity Amikacin can cause nephrotoxicity and ototoxicity (cochlear and vestibular). The risk of amikacin toxicity increases with increasing duration of therapy and may occur irrespective of amikacin concentration.

Nephrotoxicity:

- Signs of amikacin nephrotoxicity include; reduced urine output/ oliguria or increased creatinine.
- Consider an alternative antimicrobial agent if creatinine is increasing or the patient becomes oliguric.

Oto/vestibular toxicity:

- Signs of amikacin **oto/ vestibular toxicity** include: new tinnitus, dizziness, poor balance, hearing loss, oscillating vision
- Patients should be advised to report signs of ototoxicity (see Patient Information Leaflet below) and they should be asked about any signs and symptoms of ototoxicity regularly. This discussion should be documented in the patient's clinical notes. If ototoxicity is suspected, stop amikacin therapy immediately and discuss with an infection specialist.
- If amikacin continues for >5 days, suggest referral to audiology for assessment.
- The mitrochondrial DNA mutation m.1555A>G predisposes to severe hearing loss following aminoglycoside exposure. Consider the need for genetic testing, especially in patients requiring recurrent or long-term treatment with aminoglycosides (e.g. complex drug resistant infections including tuberculosis, cystic fibrosis or recurrent neutropenic sepsis) but DO NOT delay urgent treatment in order to test. Results can take up to 28 days to be reported. If required, please refer to and complete the Genetics test request form.

Step 4: Duration of amikacin therapy

- An Infection specialist should be consulted to advise on the duration and ongoing management of ALL patients prescribed amikacin.
- If discharge/ OPAT is being considered the patient should be referred to the OPAT service via Trakcare referral.

Step 5: Amikacin Patient Information Leaflet

The prescriber should issue the NHS GGC amikacin patient information leaflet (PIL, see Appendix 2) to the patient/ carer at the earliest opportunity, unless this is considered inappropriate. Any reason for non-issue of the amikacin PIL should be recorded on the amikacin PAM chart.

Reference:
Siebinga H et al. Population pharmacokinetic evaluation and optimization of amikacin dosage regimens for the management of mycobacterial infections. Journal of Antimicrobial Chemotherapy, 2020; 75 (10): 2933 – 2940.

APPENDICES

1. Adult Intravenous (IV) Amikacin (GGC): Prescribing, Administration and Monitoring (PAM) chart

2. NHS GGC Intravenous Amikacin Patient Information Leaflet

ADULT INTRAVENOUS (IV) AMIKACIN: PRESCRIBING, ADMINISTRATION & MONITORING CHART

Refer to full GGC guidance for more information/ EXCLUSIONS & Cautions / Contra-indications. All patients prescribed amikacin should be discussed with an infection specialist.

Patient name: .....

Date of birth: .....

CHI no.: .....

Affix patient label

The prescriber should issue the amikacin patient information leaflet (PIL) to the patient/ carer as soon as possible (unless this is considered to be inappropriate).

PIL issued to: patient ❑ Other: .....

Reason(s) for non-issue: .....

Date of issue: ..... Signature: .....

Age: ..... Sex: M / F

Weight: ..... Height: .....

Creatinine: ..... on: ..... /..... /.....

Initial Amikacin Dose*:

Predicted Frequency*:

*this is not a prescription and may change. Doses must be prescribed individually **below.**

Step 1: Calculate and prescribe amikacin dose:

- This Prescribing, Administration & Monitoring chart covers dosage regimens for two different AMIKACIN indications (ensure you choose the correct one for your patient). Refer to these guidelines for more information:
  - ❑ Management of Gram-negative infections
  - ❑ Management of Mycobacterial (Tuberculosis and Non-tuberculosis) Infections
- Prescribe amikacin on 'as per chart' on HEPMA.
- Prescribe individual doses in the prescription record section below, specifying the date and time the dose should be given.
- DO NOT prescribe doses in advance of the day they are due.

Step 2: Monitor creatinine and amikacin concentrations and reassess the dosage regimen.

Step 3: Assess daily for signs of renal/ oto-vestibular toxicity, response and the ongoing need for amikacin.

PROMPT ADMINISTRATION within 1 hour of recognition of sepsis reduces mortality. TOXICITY may occur irrespective of amikacin concentration.

Step 4: Upon discontinuation of therapy, ensure the amikacin prescription is stopped on both HEPMA and this prescribing chart.

TOXICITY Before prescribing each dose check: **Renal** & **Oto-vestibular function**	**IV AMIKACIN Prescription Record**				**Administration Record**			**Monitoring Record**			
	Complete each time a dose is to be given (ensure amikacin is also prescribed PRN on HEPMA)				Complete each time amikacin is administered (**in addition to HEPMA**)			Record ALL sample dates/times accurately below. See attached guidelines for monitoring advice.			
	Date to be given	Time to be given 24 h clock	Amikacin Dose (mg)	Prescriber's signature, PRINTED name and STATUS	*Infuse over 30 mins* Date given	*Infuse over 30 mins* Time started 24 h clock	Given by	Date of sample	Time of sample 24 h clock	Amikacin level (mg/L)	Action e.g. Continue/ withhold/ stop therapy (please initial & date)
Cr = micromol /L											Details:
Cr = micromol /L											Details:
***Discuss with infectious disease or microbiology and document this in the notes if treatment continues beyond 3 to 4 days * Risks of prolonged treatment must be considered and treatment options discussed with infectious diseases or microbiology.**											
Cr = micromol /L											Details:
Cr = micromol /L											Details:
Cr = micromol /L											Details:

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ADULT INTRAVENOUS (IV) AMIKACIN: PRESCRIBING, ADMINISTRATION & MONITORING CHART

Patient name: ……. **CHI no.:** ……..

TOXICITY Before prescribing each dose check: **Renal** & **Oto-vestibular function**	**IV AMIKACIN Prescription Record**				**Administration Record**			**Monitoring Record**			
	Complete each time a dose is to be given (ensure amikacin is prescribed PRN on HEPMA)				Complete each time amikacin is administered (**in addition to HEPMA**)			Record ALL sample dates/times accurately below. See attached guidelines for monitoring advice.			
	Date to be given	Time to be given 24 h clock	Amikacin Dose (mg)	Prescriber's signature, PRINTED name and STATUS	*Infuse over 30 mins* Date given	*Infuse over 30 mins* Time started 24 h clock	Given by	Date of sample	Time of sample 24 h clock	Amikacin level (mg/L)	Action e.g. Continue/ withhold/ stop therapy (please initial & date)
Cr = micromol /L											Details:
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Information for patients about Intravenous Amikacin

NHS Greater Glasgow and Clyde

Why have I been given this leaflet?

This leaflet gives you some important information on a medicine called amikacin. This is to help you to:

- Be more involved in your treatment
- Understand why we take blood samples
- Be aware of the important potential side effects of amikacin
- Understand the importance of letting the doctor, nurse or pharmacist know if you have any side effects
- Feel able to ask questions about your treatment

What is amikacin and what is it used for?

Amikacin is a powerful antibiotic that we use to treat certain types of serious bacterial infections. We have prescribed you amikacin because it is the appropriate antibiotic for your infection.

When serious infection is suspected doctors aim to give amikacin as soon as possible. Therefore if you are very unwell we sometimes start treatment before you or your family have had a chance to read this leaflet.

If you answer 'Yes' to any of these questions, please tell your doctor, nurse or pharmacist immediately:

- Do you have any hearing or balance problems, or have you (or your relatives) had hearing or balance problems as a side effect from previous antibiotic use?
- Do you (or your relatives) have a mitochondrial disease (mutations in the parts of your cells which help make energy)?
- Are you allergic to amikacin or any other antibiotics?
- Are you pregnant or breast feeding?
- Do you have reduced kidney function?
- Do you have myasthenia gravis?
- Are you taking any other medicines: including 'water tablets' such as furosemide; over the counter medications; or herbal remedies?
- Have you taken amikacin before?

How is amikacin given?

The nurses in hospital will give you amikacin as an injection into a vein or via a drip. We may change the dose and how often you take it during the course of treatment.

How will I be monitored?

We will measure the amount of amikacin in your blood to make sure you are on the right dose by taking a blood test. This will also tell us how your kidneys are working. You may also need a hearing and balance test (see possible side effects).

How long will I take amikacin?

Often you will take amikacin for up to 4 days. If you need amikacin for more than 5 days, your doctor will arrange for you to have hearing and balance tests (see possible side effects).

What are the possible side effects?

Like all medicines, amikacin may cause side effects. However, most are rare and not all patients will experience them. **It is extremely important that you tell your doctor, nurse or pharmacist if you experience any of these side effects at any time** as they could be serious or long-term.

- **Reduced kidney function**: you might not have any symptoms but may notice you are passing less urine
- **Allergic reactions**: including rash, itch, fever, shortness of breath, a tight chest or wheezing, chills or shivers, swelling or redness of the skin
- **Hearing or balance problems**, these may include:
  - **Hearing impairment**: you may experience a ringing in your ears (tinnitus) or hearing loss
  - **Disturbances in balance:** you may feel dizzy or have difficulty in keeping your balance
  - **Visual disturbances:** you may experience jerky or bouncing vision

If you have any questions while in hospital, please ask a member of staff. When you go home, you should contact your GP, Practice Nurse or Community Pharmacist for any further advice if required. If you are ill on a day or at a time when your GP surgery is closed, you can call NHS 24 on 111.

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