Royal United Hospital Bath NHS
NHS Trust

Guidelines for the Dosing and Monitoring of Gentamicin, Vancomycin and Teicoplanin

General points:

- Antibiotic assays for vancomycin and gentamicin are performed by Biochemistry. All results will be available on the computer as soon as the test is complete. Samples will be analysed at anytime during the day (Mon-Fri) up to 5pm for samples received before 4pm. Results will be available on the computer within 2-3 hours of receipt. Samples received during the night will be run first thing the following morning. On Saturday, Sundays and Bank Holidays, an additional batch will be analysed at 6pm (samples must be received by 5pm).

- Any concerns regarding a delay in a particular patient, please contact Medical Microbiologist for advice

- Assays for teicoplanin and tobramycin are sent away for testing and results may not be back until the following day.

- Abnormal (out of range) assays will not be telephoned by the Microbiology or Biochemistry Department to the ward or clinician, and it is the responsibility of the clinician taking the sample to access and act on those results.

- Assays results have comments appended showing the acceptable range for levels. It is essential that all levels/assays are taken at the correct time (which is immediately before the dose is due for pre-dose levels). Incorrect timing will make interpretation of levels impossible.

- The Medical Microbiologists, antimicrobial pharmacist or ward pharmacist will be available for advice on managing patients whose levels are out of range. However, calls to microbiology will only be taken from medical staff**.** Enquiries from nursing staff should be directed to the doctors responsible for the patient.

- Send a clotted specimen (SST yellow top, not heparin) together with a single YELLOW Antibiotic Assay request form to pathology reception. Please ensure that **ALL details on the request form are completed** including details of whom to contact in the event of a problem. Please do not request other tests from the same sample.

- Once a level has been taken, doses should only be withheld if there is concern that the level will be too high due to poor or deteriorating renal function or if patient is over 65 years.

- All IV antibiotics should be reviewed after 48 hours. Unless for specific respiratory indications, patients should not be given more than 7 days of gentamicin without discussion with a Microbiologist

Guidelines for the Dosing and Monitoring of Gentamicin, Vancomycin and Teicoplanin

Contents

Guidelines for Once Daily Gentamicin Dosing in Adults

1. Check for exclusions:

Gentamicin should not be used in the following patient groups:	Once daily dosing should not be used in patients with:
• Myasthenia Gravis • Hypersensitvity to aminoglycosides • Severe renal impairment	• Infective Endocarditis • Major Burns (>20% of body surface area) • Pregnancy

If present discuss alternative antibiotics with Microbiologist

2. Dose Determination and Administration

- The standard **prophylaxis** dose is **3mg/kg**
- The standard **treatment** dose is **5mg/kg**,
- No single dose of Gentamicin should exceed 520mg
- Doses should be rounded down to the nearest 40mg
- The dose for neutropenic sepsis is 6mg/kg, maximum dose at discretion of prescribing clinician
- Doses of 5mg/kg or more should be given over 30 minutes to diminish the theoretical risk of a rapid rise in serum concentrations that might precipitate neuromuscular blockade

Non-obese
Use actual body weight to determine the dose.

Obese (> 20% above ideal body weight)
Gentamicin distributes poorly into adipose tissue. Patients who are obese should receive a relatively lower dose of gentamicin.

Figure 1 (for all male patients) and figure 2 (for all female patients) below give suggested doses of Gentamicin **5mg/kg** according to height and actual body weight and take into account a correction factor for obese patients. Please use these tables at your discretion.

- Most calculated doses have been rounded down to the nearest 40mg.
- Appendix 1 explains in further detail the dose calculations for obese patients and includes graphs showing ideal body weight and 20% above ideal body weight. The calculations shown in Appendix 1 can be used for any dose of Gentamicin.

Figure 1 Suggested gentamicin doses of 5mg/kg according to height and weight in MALE patients, taking into account a correction factor for obese patients

Male

Height in feet	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180	185	190
6' 5	280	320	320	360	400	400	440	440	480	480	480	480	480	480	520	520	520	520	520	520	520	520	520	520	520	520	520
6' 4	280	320	320	360	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520	520	520	520	520
6' 3	280	320	320	360	400	400	440	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520	520	520	520
6' 2	280	320	320	360	400	400	440	440	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520	520	520
6' 1	280	320	320	360	400	400	440	440	440	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520	520
6' 0	280	320	320	360	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520	520
5' 11	280	320	320	360	400	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520	520
5' 10	280	320	320	360	400	400	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520
5' 9	280	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520	520
5' 8	280	320	320	360	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520	520
5' 7	280	320	320	360	360	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520
5' 6	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520	520
5' 5	280	320	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520
5' 4	280	320	320	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520
5' 3	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520
5' 2	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520
5' 1	280	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520
5' 0	280	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520

Actual weight in kg

Figure 2 Suggested gentamicin doses of 5mg/kg according to height and weight in FEMALE patients, taking into account a correction factor for obese patients

Female

Height in feet	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165
6' 3	200	240	240	280	320	320	360	400	400	440	440	440	440	440	440	480	480	480	480	520	520	520	520	520	520
6' 2	200	240	240	280	320	320	360	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520	520
6' 1	200	240	240	280	320	320	360	400	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520	520
6' 0	200	240	240	280	320	320	360	400	400	400	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520
5' 11	200	240	240	280	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520	520
5' 10	200	240	240	280	320	320	360	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520	520
5' 9	200	240	240	280	320	320	360	360	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520
5' 8	200	240	240	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480	520
5' 7	200	240	240	280	320	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480	480
5' 6	200	240	240	280	320	320	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480
5' 5	200	240	240	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480	480
5' 4	200	240	240	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480	480
5' 3	200	240	240	280	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480
5' 2	200	240	240	280	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440	480
5' 1	200	240	240	240	240	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440	440
5' 0	200	240	240	240	240	240	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440	440
4' 11	200	240	240	240	240	240	240	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440
4' 10	200	200	200	240	240	240	240	280	280	280	280	320	320	320	320	360	360	360	360	400	400	400	400	440	440

Actual weight in kg

3. Dosing interval and monitoring

Gentamicin is cleared predominantly via the kidneys and the dosage interval needs to be increased in patients with impaired renal function. Judgement is necessary to decide category of renal function. Estimated glomerular filtration rate (eGFR) has been provided as a guide if required but it is not a perfect marker and is not accurate in extremes of body shape or acute renal impairment. Please see Appendix 2 for further details.

Renal Function	Suggested eGFR (ml/min/1.73m^2)	Dose Time interval	First assay time	Do I give next dose before assay results available?
Normal	> 60	24 hours	Check level 24 hours post dose	In patients <65 years old, with good urine output give 2nd dose without waiting for result In patients >65 years old, wait for result before giving 2nd dose
Impaired	30-60	Dependent on levels	Check level 24 hours post dose	Wait for result before giving any further doses
Severe Impairment	< 30	Discuss with microbiology		

- Take pre dose levels up to one hour before the second dose is given
- Patients >65 years old, or with abnormal renal function or poor urine output: the pre dose gentamicin level must be **≤1mg/litre** before any further dose is given
- For patients with normal and stable renal function check pre dose level twice weekly
- For patients with abnormal renal function, check the pre dose gentamicin level before each dose
- If further advice on any aspect of dosing or monitoring is required, please discuss with a Microbiologist or Pharmacist

Renal function must be checked regularly. If renal function deteriorates, more frequent monitoring may be needed, the dosing interval may need to be increased or discontinuation of therapy may be required. Discuss alternative antibiotics with a Microbiologist.

4. Interpretation of levels

RESULT	ACTION
Pre-dose level ≤1mg/L	Continue current therapy
Pre-dose level >1mg/L (HIGH)	• Withhold next dose and review for reason why pre-dose level is high. • Check that that the dose prescribed and timing of the level are correct. High levels can result from samples being taken too early. If timing was incorrect, re-check the level at the appropriate time. • Check where the blood sample was taken from. Falsely high levels may occur as a result of sampling from the line that the drug was administered through. • The pre-dose gentamicin level must be ≤1mg/L before a further dose is given. If the timing and sampling are correct, levels will need to be repeated at 12–24 hours depending on the original result. It may be necessary to increase the dosing interval. If Gentamicin is re-started, re-check levels before the next dose. • Monitor renal function: an increased pre-dose level may be associated with a deteriorating renal function.

5. Duration

Patients should not normally be given more than 7 days of Gentamicin without discussion with a Microbiologist

Summary of monitoring requirements for aminoglycoside for different indications

ANTIBIOTIC	USUAL DOSING REGIME	FIRST ASSAY TIME	EXPECTED RESULT	RE-ASSAY INTERVAL
Gentamicin	5 mg/kg OD (treatment dose) Dose interval adjusted according to renal function Neutropenic patients: 6mg/kg OD	• If renal function normal and patient less than 65 years old, with good urine output take **pre-dose** level just before the second dose at 24hrs, then give dose. • If renal function impaired or patient over 65 years take **pre-dose** level before the second dose is due but await result before giving dose.	<1mg/l	• If renal function stable and pre-dose levels <1mg/l check levels twice weekly • If renal function impaired check pre dose level before each dose is due
Gentamicin for Infective Endocarditis	1mg/kg TDS	• If renal function normal, assay before and after the third **or** fourth dose. • Take **pre-dose** level just before dose is due, and **post dose** 1 hour after administration.	Pre-dose <1mg/l Post-dose 3-5 mg/l	If renal function stable and levels in range check levels twice weekly
Tobramycin	Bronchiectasis: 4mg/kg OD Cystic Fibrosis only: 10mg/kg OD	• If renal function normal take **pre-dose** level just before the second dose at 24hrs then give dose. • If renal function impaired take **pre-dose** level as above but await result before giving second dose.	<1mg/l	Twice weekly if renal function stable and levels in range

Guidelines for Vancomycin Dosing and Monitoring

1. Exclusions

Vancomycin should not be used in the following patients:

- Hypersensitivity to Glycopeptides
- Major Burns (>20% of body surface area)
- Pregnancy

If present, discuss alternative antibiotics with a Microbiologist

2. Dose Determination and Dosing Interval

Vancomycin is excreted almost entirely via the kidney. Serum levels are monitored to reduce the risk of significant accumulation and nephrotoxicity. Dose is adjusted according to age and renal function. Judgement is necessary to decide category of renal function. eGFR has been provided as a guide if required but it is not a perfect marker and is not accurate in extremes of body shape or acute renal impairment. Please see Appendix 2 for further details.

Table 1 Normal Renal Function

Age (years)	Vancomycin Dose	Dose Frequency
<65	1000mg	12 hourly
65-75	750mg	12 hourly
>75	500mg	12 hourly

Table 2 Impaired Renal Function:

Renal Impairment	Suggested eGFR (ml/min/1.73m^2)	Age (years)	Vancomycin Dose	Dose Frequency
Mild	45-60	<65	750mg	12 hourly
		65-75	500mg	12 hourly
		>75	1000mg	measure level at 24h and await the result before giving the next dose
Moderate or Severe	<45	All ages	1000mg	measure level at 24h and await the result before giving the next dose

Renal function must be checked regularly. If renal function deteriorates more frequent monitoring may be needed.

If further advice on any aspect of dosing or monitoring is required, please discuss with a Microbiologist or Pharmacist

3. Administration

Vancomycin is administered by slow infusion (maximum rate 10mg per minute) to avoid red man syndrome. See intravenous drug administration manual for further details.

4. Monitoring of Levels

FIRST ASSAY TIME	• Take **pre dose** level immediately before the 3rd or 4th dose, or as directed in Table 2 in patients with impaired renal function
DO I GIVE NEXT DOSE BEFORE ASSAY RESULT AVAILABLE?	• Give the next dose without waiting for the result of the level unless stated in Table 2 or patient has deteriorating renal function
EXPECTED LEVEL	5-15mg/l Aim for pre-dose levels of 10-15mg/l for serious or deep seated infections
RE-ASSAY INTERVAL	• Assay twice weekly if pre-dose levels <15mg/l and renal function stable • Patients with unstable renal function should have a pre-dose serum Vancomycin level is before each dose is given

- There is no need to measure peak (post dose) serum levels.
- On the request form state clearly the exact time when the last dose of Vancomycin was given and when the sample was taken.

5. Interpretation of Levels

RESULT	ACTION
Pre-dose level LOW <5mg/L or <10mg/L for deep-seated infections	• Check to ensure that previous doses have been given as prescribed. Low levels can result from samples being taken too late or from doses being missed. • If the level is low and renal function is stable - increase the dose and re-check levels as per 'first assay time' above.
Pre-dose level 5-15mg/L or 10-15mg/L for deep-seated infection	Continue current therapy, re-check levels in 3 days if renal function stable
Pre-dose level HIGH >15mg/L	• Check that that the dose prescribed and timing of the level are correct. High levels can result from samples being taken too early. If timing is incorrect, re-check the level at the appropriate time. • Check where the blood sample was taken from. Falsely high levels may occur as a result of sampling from the line that the drug was administered through. • If the timing and sampling are correct and renal function is stable, consider omitting a dose and then either increase the dosing interval or reduce the dose. Re-check levels as per 'first assay time' above. • If the level is very high or renal function is deteriorating then omit Vancomycin until levels are within range and discuss re-starting with a Microbiologist. • Monitor renal function: an increased pre-dose level may be associated with a deteriorating renal function.

If levels are sub-therapeutic on 1000mg 12 hourly (pre dose level <5mg/L or <10mg/L for deep-seated infections), it is reasonable to give higher doses. Prescribe 1.25g 12 hourly in the first instance. If doses over 1.5g 12 hourly are required, discuss with Microbiology.

Summary of Teicoplanin Dosing and Monitoring

USUAL DOSING REGIME	400mg OD with additional loading dose 12 hours after the first dose May require 10mg/kg in deep-seated or severe infection, discuss with Microbiologist
LEVEL	**Pre-dose**
FIRST ASSAY TIME	• Assay required in patients receiving therapy for serious or deep-seated infections, patients with impaired renal function and patients on long treatment courses • Levels are rarely indicated before day 4 of treatment even in renal impairment
DO I GIVE NEXT DOSE BEFORE ASSAY RESULT AVAILABLE?	• Teicoplanin assays are sent away for testing and may not be back until the following day • Give the next dose without waiting for the result of the level
EXPECTED LEVEL	*Staph aureus*: >20mg/l but <60mg/l Other infections: >10 mg/l but <60mg/l
RE-ASSAY INTERVAL	• Assay once a week if pre-dose levels within range and renal function stable

Appendix 1: How to calculate Gentamicin dosage in obese patients

1. Assess if patient >20% above ideal body weight

Using the patients actual height and body weight, refer to figure 3 (for male patients) and figure 4 (for female patients) to assess whether patient is >20% above ideal body weight

Figure 3: Obesity categorisation for **male** patients. If the patient falls in the red shaded area, then they are categorised as obese. For those who fall in the green shaded area, use the actual body weight to calculate the dose of gentamicin

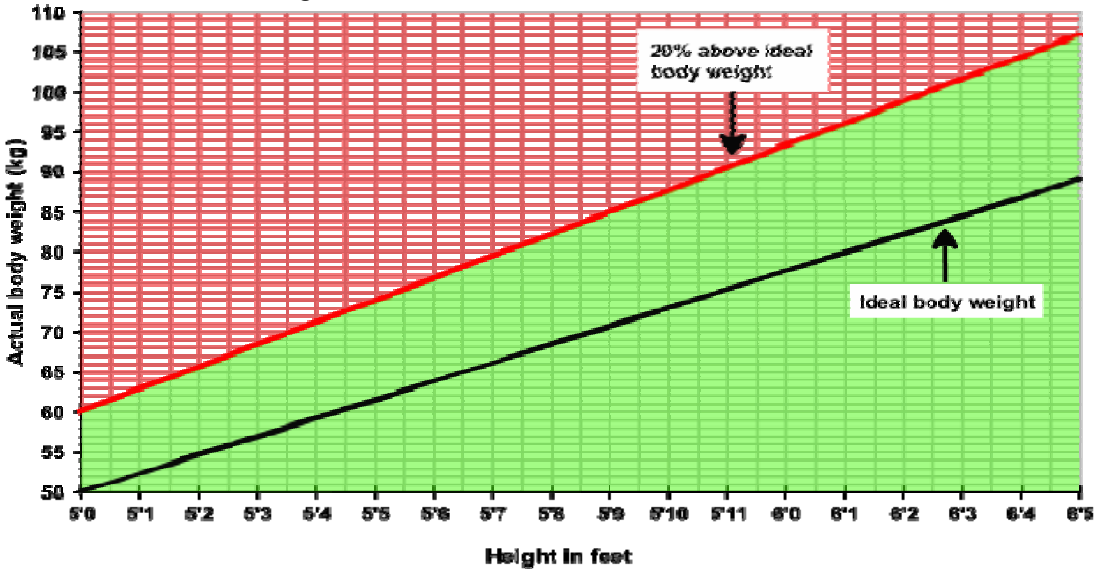
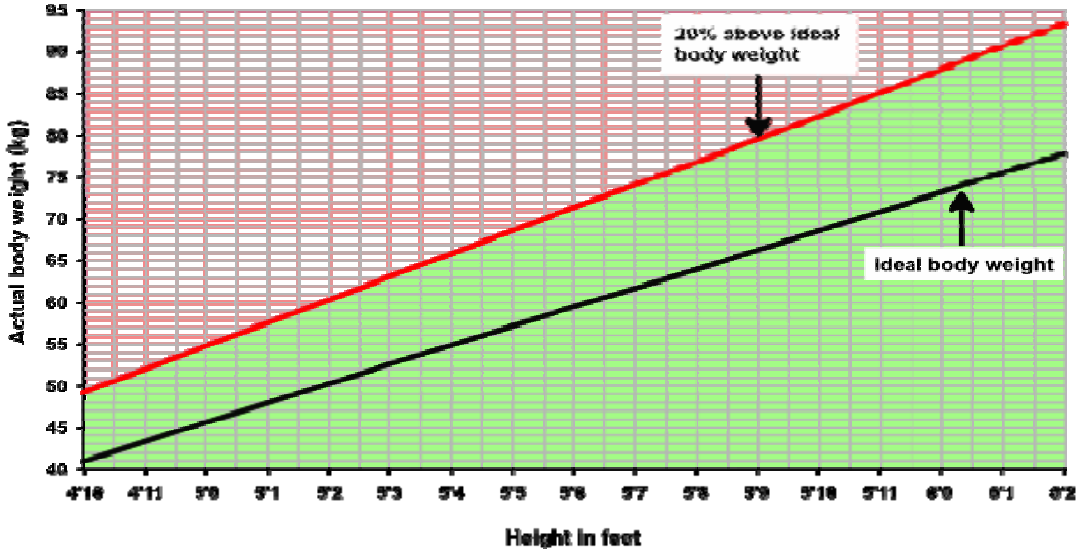


Figure 4: Obesity categorization for **female** patients. If the patient falls in the red shaded area, then they are categorised as obese. For those who fall in the green shaded area, use the actual body weight to calculate the dose of gentamicin



2. Calculate Ideal body weight and corrected weight

Calculate the patient's ideal body weight (IBW) and corrected weight using the following formulae:

Corrected weight = IBW + 0.4 x (actual body weight - IBW)

IBW:	Men	50kg + 2.3kg per inch over 5 feet
	Women	45.5kg + 2.3kg per inch over 5 feet

3. Calculate the dose

Use the corrected weight to calculate the dose. Multiply the corrected weight by the required dose (e.g. 5mg/kg) and round down to the nearest multiple of 40.

Appendix 2: Renal Function and eGFR

- eGFR is an estimation of renal function based on serum creatinine level, age and sex
- In these guidelines eGFR has been provided as a guide to renal function but it is not a perfect marker
- Please note the following cautions about eGFR:
    - it is not accurate in obesity or in people with abnormal amounts of muscle, GFR will be underestimated in those with increased muscle mass and over-estimated in those with reduced muscle mass such as amputees and malnourished people
    - it is not accurate in people who have conditions that can affect the level of creatinine such as people with acute renal failure
    - it is accurate in patients with chronic kidney disease but it under-estimates GFR in people with normal or near-normal renal function
    - it is not valid in pregnant women or in children
    - laboratory reported eGFR is not validated for certain racial groups - increase the reported eGFR by 21% for Afro-Caribbean black patients
    - creatinine levels/renal function should be relatively stable and not rapidly changing for the reported eGFR to be valid

References:

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Figures 1, 2 , 3 and 4 adapted from University Hospitals Bristol Guidelines with kind permission from Dr Martin Williams

Chronic Kidney Disease - national clinical guideline for early identification and management in adults in primary and secondary care. Produced by The National Collaborating Centre for Chronic Conditions. Published by Royal College of Physicians 2008.