Original Article

Evaluation of the Safety of a Vancomycin Nomogram Used to Achieve Target Trough Concentrations

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ABSTRACT

Background: Dosing vancomycin to achieve target concentrations of 15 to 20 mg/L has been recommended for select infections. To date, few vancomycin nomograms designed to target these higher concentrations have been published, and only one has been published in North America. Based on the success of this nomogram in developing empiric vancomycin regimens that achieve higher target trough concentrations with low rates of nephrotoxicity, a vancomycin nomogram targeting concentrations of 15 to 20 mg/L was developed and implemented at Emory University Hospital and Emory University Hospital Midtown.

Objective: To evaluate the impact of a vancomycin-dosing nomogram on the incidence of vancomycin-associated nephrotoxicity and the time to achieve targeted trough concentrations.

Methods: A retrospective chart review of 200 patients who received vancomycin dosed to achieve target trough serum concentrations of 15 to 20 mg/L was performed.

Results: After implementation of the vancomycin nomogram, no statistically significant difference in incidence of vancomycin-associated nephrotoxicity was found (14% vs 16%; $P = .197$). Fewer patients had an initial vancomycin trough concentration within target range (29.1% vs 21.7%; $P < .001$). Adherence to the nomogram was poor, with only 41% of patients being dosed per the nomogram's recommendations.

Conclusion: Based on our results, implementation of a vancomycin dosing nomogram had no impact on the incidence of nephrotoxicity, and significantly fewer patients had an initial vancomycin trough within the target range of 15 to 20 mg/L. The clinical utility of a vancomycin dosing nomogram is still to be determined.

Key Words—dosing, nephrotoxicity, nomogram, therapeutic monitoring, vancomycin

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Vancomycin is a glycopeptide antibiotic that has been in clinical use for over 50 years. It is one of the most frequently used antimicrobials for the treatment of infections caused by resistant gram-positive organisms, including methicillin-resistant *Staphylococcus aureus*. Vancomycin has been associated with various adverse events, most notably, nephrotoxicity. The incidence of vancomycin-associated nephrotoxicity has been studied extensively,

and documented incidences of nephrotoxicity have varied widely, ranging from 0% to 30% when vancomycin is administered with other nephrotoxic agents.¹ More recently, studies have found the incidence of nephrotoxicity to be higher when vancomycin is dosed to achieve target trough concentrations of 15 to 20 mg/L than when it is dosed to achieve the previously recommended trough concentrations of 10 to 15 mg/L.^{2–7} This higher trough concentration

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range is recommended by the American Society of Health-System Pharmacists (ASHP), the Infectious Disease Society of America (IDSA), and the Society of Infectious Diseases Pharmacists (SIDP) for hospital-acquired pneumonia as well as other complicated infections including bacteremia, endocarditis, osteomyelitis, and meningitis.^{8,9} A trough concentration of 15 to 20 mg/L was recommended in these patients with complicated infections to potentially improve drug penetration and clinical outcomes. To help guide empirical vancomycin dosing to achieve this higher target trough concentration range, vancomycin dosing nomograms have been developed. Vancomycin nomograms are generally easy to use and can improve efficiency when determining empiric vancomycin regimens. However, nomograms do not include many patient-specific factors. Due to the risk of vancomycin-associated nephrotoxicity, especially when targeting higher trough concentrations, it is essential to determine which patients may or may not be candidates for the nomogram.

To date, few nomograms designed to target this higher range have been developed and published, with only one nomogram published in North America.¹⁰⁻¹³ The nomogram published in North America, developed by Kullar and colleagues, was the first nomogram to target trough concentrations of 15 to 20 mg/L.¹⁰ This prospective study did not have a control group, but it analyzed achievement of target trough concentrations and rates of nephrotoxicity within a population of patients. Within the study, 58% of patients achieved the initial target trough of 15 to 20 mg/L and 77% of patients eventually achieved target concentrations within a median of 48 hours. Furthermore, only 4.5% of patients developed nephrotoxicity. Based on the success of the nomogram, a similar vancomycin dosing nomogram (**Appendix**) was adopted at Emory University Hospital (EUH) and Emory University Hospital Midtown (EUHM), Atlanta, Georgia. The nomogram was implemented at EUH on October 3, 2011, and at EUHM on February 1, 2012.

The published nomogram by Kullar and colleagues was evaluated in a relatively young and medically stable patient population, so this published nomogram was implemented at EUH and EUHM for use only in patients who were 55 years old or younger, had stable renal function, and were not receiving concomitant nephrotoxic agents. For patients older than 55 years and receiving concomitant nephrotoxic agents, a new nomogram with more

conservative dosing was developed and implemented (**Appendix**). In addition, a vancomycin loading dose, which was not included in the published nomogram, was incorporated into both nomograms implemented at EUH and EUHM. Prior to implementation of the new nomograms, extensive education was provided to all pharmacists at EUH and EUHM. The education included information about the development of the nomograms and provided guidance on how to appropriately utilize the nomograms. Because nomograms are developed to help determine empiric regimens only, if a measured trough concentration fell outside the target range, pharmacists were instructed to make dose adjustments based on standard pharmacokinetic equations.

The primary objective of this study was to evaluate the impact of the implemented vancomycin nomograms at EUH and EUHM on the incidence of nephrotoxicity. The secondary objectives of the study included evaluating the appropriate use of the nomograms based on the documented indication for vancomycin therapy and evaluating the impact of the nomograms on vancomycin trough concentrations and time to achieve target trough concentrations.

METHODS

This institutional review board–approved, retrospective, dual-center study with a historical control, was performed at EUH and EUHM, 2 of the 6 hospitals that comprise Emory Healthcare, the largest health care system in Georgia. Both hospitals are tertiary care academic medical centers in Atlanta, with a high level of acuity. EUH is a 587-bed hospital with a large transplant and hematology/oncology patient population. EUHM is a 511-bed hospital with a level III neonatal intensive care unit, and it offers a full range of services, including general medicine, maternal and infant care, orthopedics, and surgery. Adult patients who had vancomycin therapy initiated and dosed to achieve target trough concentrations of 15 to 20 mg/L were eligible for inclusion in the study. Those patients who received vancomycin dosed to achieve target trough concentrations of 15 to 20 mg/L 3 months prior to implementation of the nomograms were eligible for inclusion in the pre-vancomycin nomogram group. This group served as the historical control. Patients who had vancomycin dosed to achieve target trough concentrations of 15 to 20 mg/L 3 months after implementation of the nomograms were eligible for inclusion in the post-vancomycin nomogram group. Patients were excluded if there was

no weight or serum creatinine recorded on the date of initiation of vancomycin therapy, if they had a known history of end-stage renal disease or were receiving dialysis at baseline, if they received 48 hours or less of vancomycin therapy, or if they were initiated on vancomycin therapy while on a hospital service covered by a pharmacy clinical specialist. Patients who had vancomycin dosed by pharmacy clinical specialists were excluded from the study, because the pharmacy clinical specialists at EUH and EUHM do not consistently utilize the vancomycin nomograms. These patients were excluded to optimize the inclusion of patients in the study who had vancomycin dosed per the nomograms. The pharmacy clinical specialists at EUH and EUHM do not consistently utilize the vancomycin nomograms because they primarily take care of critically ill patients with rapidly changing renal function and utilization of nomograms in general is not recommended in patients with unstable renal function. Although utilization of the nomograms is not mandatory and based on pharmacist preference, every vancomycin order from a physician at EUH and EUHM results in an automatic pharmacokinetic consult and therefore all patients, and those patients included in the study, have vancomycin dosed and managed by pharmacists.

Definitions

In this study, nephrotoxicity was defined as an increase in serum creatinine concentration of 50% or 0.5 mg/L, whichever was greater, for at least 2

consecutive measurements occurring from the start of vancomycin therapy through 24 hours after completion of vancomycin therapy. Instead of the RIFLE criteria, this definition of nephrotoxicity was chosen because it is similar to the definition of vancomycin-associated nephrotoxicity provided in the vancomycin consensus guidelines⁸ and is similar to the definition used by Kullar and colleagues in evaluation of their published nomogram.¹⁰

Statistical Analysis

Comparisons between the pre-vancomycin group and post-vancomycin nomogram group were evaluated using the chi-square test for categorical variables and the Student *t* test for continuous variables. All calculations were computed using Excel and JMP 10. A *P* value less than .05 was considered statistically significant.

RESULTS

A total of 572 patients were evaluated for inclusion in the study and 372 patients were excluded. The majority of patients were excluded because they received vancomycin for 48 hours or less (**Figure 1**). One hundred patients who received vancomycin dosed to achieve trough concentrations of 15 to 20 mg/L between July 1, 2011 and September 30, 2011 were included in the pre-vancomycin nomogram group and 100 patients who received vancomycin dosed to achieve trough concentrations of 15 to 20 mg/L between February 15, 2012 and April 15,

Figure 1. Study flow diagram. ESRD = end-stage renal disease; EUH = Emory University Hospital; EUHM = Emory University Hospital Midtown.

2012 were included in the post-vancomycin nomogram group. The patient demographics and clinical characteristics are shown in Table 1. Based on the characteristics evaluated, there were no statistically significant differences between the 2 groups, with the exception of a statistically significant higher percentage of patients receiving intravenous contrast in the post-vancomycin nomogram group (23% vs 37%; $P = .03$). The documented indication for vancomycin was evaluated; although statistics were unable to be performed for each indication due to the small numbers in each group, the indications were relatively

similar between the 2 groups, with the exception of a higher percentage of patients being treated for bacteremia in the pre-vancomycin nomogram group (28% vs 11%) and a higher percentage of patients being treated for pneumonia and skin and soft tissue infections in the post-vancomycin nomogram group (22% vs 34% and 5% vs 10%, respectively) (Table 1).

Based on our results, there was no statistically significant difference in the incidence of nephrotoxicity prior to and after implementation of the vancomycin nomograms (16% vs 14%; $P = .197$) (Table 2). There were also no statistically significant differences

Table 1. Baseline patient characteristics

Characteristics	Pre-vancomycin nomogram	Post-vancomycin nomogram	<i>P</i>
Age, years, mean ($\pm$ SD)	56 ($\pm$ 17)	56 ($\pm$ 18)	NS*
Male sex, %	54	48	NS
Weight, kg, mean ($\pm$ SD)	80 ($\pm$ 23.5)	82 ($\pm$ 26)	NS
Baseline Scr, mg/dL, mean ($\pm$ SD)	1.18 ($\pm$ 0.76)	1.08 ($\pm$ 0.52)	NS
Estimated CrCL, mL/min, ($\pm$ SD)	70 ($\pm$ 29)	70 ($\pm$ 28)	NS
Select PMH, %			
Diabetes	33	27	NS
Heart failure	18	20	NS
Cancer	14	16	NS
HIV	7	5	NS
Indication for vancomycin, %			
Pneumonia	22	34	—
Bacteremia	28	11	—
Intra-abdominal	6	6	—
Osteomyelitis	8	7	—
Endocarditis	0	2	—
Neutropenic fever	3	2	—
SSTI	5	10	—
Other/unknown	33	30	—
Concomitant nephrotoxic agents, %			
IV contrast	23	37	.03
Piperacillin-tazobactam	52	50	NS
Aminoglycosides	8	7	NS

Note: CrCL = creatinine clearance; HIV = human immunodeficiency virus; IV = intravenous; NS = not statistically significant; PMH = past medical history; Scr = serum creatinine; SSTI = skin and soft tissue infection.

*Statistical test used: chi-square; level of significance considered as $P < .05$.

in mean vancomycin trough, percentage of patients with initial vancomycin troughs within the target range of 15 to 20 mg/L, percentage of patients with initial troughs above target (>20 mg/L), mean time to achieve target trough concentrations, or requirement of renal replacement therapies prior to and post implementation of the nomogram (Table 2). Opposite to what was expected, after implementation of the vancomycin nomograms, a lower percentage of patients had their initial vancomycin trough concentration within target range (29.1% vs 21.7%; $P < .001$) and a higher percentage of patients had at least one trough below target range (<15 mg/L)

during vancomycin therapy (46.5% vs 62%; $P < .001$). The distribution of vancomycin trough concentrations for the pre- and post-vancomycin nomogram groups is displayed in Figures 2 and 3.

Based on the documented indications, vancomycin therapy in only 55% of patients appropriately targeted trough concentrations of 15 to 20 mg/L according to the recommendations provided by ASHP, IDSA, and SIDP. Although this appears to be a low percentage, the documented indication for vancomycin therapy was unable to be determined for about one-third of patients (Table 3) based on chart review.

Table 2. Incidence of nephrotoxicity and vancomycin trough concentration outcomes

Outcomes	Pre-vancomycin nomogram (<i>n</i> = 100)	Post-vancomycin nomogram (<i>n</i> = 100)	<i>P</i> *
Nephrotoxicity, %	16	14	.197
Vancomycin trough, mg/L, mean ($\pm$ SD)	19.1 ($\pm$ 9.3)	17.6 ($\pm$ 8.1)	NS
Percent of patients with initial trough within target range, 15-20 mg/L	29.1	21.7	<.001
Percent of patients eventually achieving target trough, 15-20 mg/L	39.5	37	NS
Percent of patients with troughs >20 mg/L	45.3	43.5	NS
Percent of patients with troughs <15 mg/L	46.5	62	<.001
Mean time to achieve target trough, days	5.74	5.58	NS

Note: NS = not statistically significant.

*Statistical test used: chi-square for categorical variables; Student *t* test for continuous variables. Level of significance considered as $P < .05$.

Figure 2. Scatter plot of the initial vancomycin trough concentrations.

Figure 3. Box plot of the initial vancomycin trough concentrations.

Table 3. Percent of patients in which vancomycin trough concentrations of 15 to 20 mg/L were appropriately targeted based on ASHP/IDSA/SIDP recommendations

Appropriate per ASHP/IDSA/SIDP recommendations?	Indication	% of patients (n = 200)
Yes 55.5% of patients	Pneumonia	27.5
	Bacteremia	19.5
	Osteomyelitis	7.5
	Endocarditis	1
No 16% of patients	Neutropenic fever	2.5
	Intra-abdominal	6
	SSTI	7.5
31.5% Unknown	Unknown	31.5

Note: ASHP/IDSA/SIDP = American Society of Health-System Pharmacists/ Infectious Diseases Society of America/Society of Infectious Diseases Pharmacists; SSTI = skin and soft tissue infection.

Adherence to the vancomycin nomograms was poor, with only 41% of patients in the post-vancomycin nomogram group determined to have vancomycin therapy dosed per the nomograms. Adherence to the nomograms was determined by comparing the patient's initial documented vancomycin regimen with the regimen recommended by the nomograms based on the patient's calculated creatinine clearance

and weight documented on the day of the initiation of vancomycin therapy. Despite poor adherence, initial vancomycin trough concentrations from nomogram recommended regimens were still found to result in mostly below target trough concentrations (Figures 4 and 5).

DISCUSSION

In 2009, ASHP, IDSA, and SIDP published a joint consensus guideline recommending that vancomycin troughs remain above 10 mg/L at all times to limit the development of resistance and treatment failures. In addition, the guidelines proposed new target concentrations for severe infections such as pneumonia, bacteremia, endocarditis, meningitis, and osteomyelitis. To achieve these updated target troughs, larger total daily doses of vancomycin may be needed and traditional dosing of vancomycin may no longer be adequate. Historically, published nomograms were designed to achieve troughs below 15 mg/L.¹⁴⁻¹⁸ The published nomogram by Kullar and colleagues that targets trough concentrations of 15 to 20 mg/L was evaluated in a relatively young and medically stable population. Patients who weighed more than 110 kg, had a creatinine clearance less than 30 mL/min or greater than 110 mL/min, or were considered to be critically ill were excluded from the study, which limits the broad application of the nomogram. In the present study, we had limited exclusions in order to evaluate the impact of utilizing a vancomycin nomogram in a broader patient population.

Figure 4. Initial vancomycin trough concentrations from Table A (see Appendix) vancomycin regimens.

Figure 5. Initial vancomycin trough concentrations from Table B (see Appendix) vancomycin regimens.

For our primary objective, implementation of the nomograms was found to have no effect on the incidence of nephrotoxicity. However, a relatively high incidence of nephrotoxicity was seen overall; there was approximately a 3-fold higher incidence compared with the results found by Kullar and colleagues. This finding could be explained by the high percentage of patients who received concomitant nephrotoxic agents, especially intravenous contrast and piperacillin-tazobactam, in our study. In the study by Kullar and colleagues, only 7.5% of patients received concomitant nephrotoxic agents. However, this study did not take into account other factors that could have impacted the incidence of nephrotoxicity.

For our secondary objectives, implementation of the nomograms was found to have no effect on the percentage of patients with troughs above target, percentage of patients who eventually achieved target troughs, or the time to achieve target troughs of 15 to 20 mg/L. After implementation of the nomograms, a lower percentage of patients had an initial vancomycin trough within the target range of 15 to 20 mg/L, and a higher percentage of patients were found to have troughs below the target range. These results, which were opposite from what was expected, could have been impacted by limited utilization of a vancomycin loading dose of at least 20 mg/kg. Loading doses were given to 50% of patients in the pre-vancomycin

nomogram group and 49% of patients in the post-vancomycin nomogram group; although low, the incidence was similar between both groups. In addition, although only serum concentrations obtained prior to the administration of a vancomycin dose were considered “troughs” within the study, the study did not evaluate whether the initial concentration obtained was collected at steady state. Obtaining initial concentrations prior to steady state could have also resulted in a higher percentage of initial vancomycin serum concentrations being below the target range.

Limitations

This study, which is retrospective in design, has several limitations. Due to the retrospective design, the patients included in the study were not randomized according to indication, co-morbidities, gender, age, or renal function. Also, due to the retrospective design, it was difficult to determine the indication for vancomycin. Determining the indication for vancomycin is difficult in real time as well. Indication is not always documented in the medical record, because it is not required by computerized prescriber order entry (CPOE) when physicians order antimicrobials. As a result, the incorrect goal trough concentration (15-20 mg/L vs 10-15 mg/L) may be targeted. Another limitation is the time frame in which the study was conducted. Three months after implementation of the nomograms may have been too early to detect their impact in patients who received vancomycin. Although education was provided prior to the roll out of the nomograms, pharmacists may still have been gaining comfort in appropriately utilizing the nomograms during this period. Furthermore, pharmacists could have chosen to continue using other methods for dosing vancomycin, as utilization of the nomograms was not mandatory. This could have also impacted the low adherence rates to the nomograms seen in the study. Evaluating more patients with vancomycin specifically dosed per the nomograms could provide more information on the usefulness of the nomograms and help provide insight to any changes that may need to be made.

Conclusion

The implementation of vancomycin dosing nomograms was found to have no impact on the incidence of nephrotoxicity and instead resulted in fewer patients with initial vancomycin troughs within the target range of 15 to 20 mg/L as well as a higher percentage of patients with troughs below

target range. Based on these results, the clinical utility of a vancomycin dosing nomogram in a broad, medically complex patient population is still to be determined. Although dosing nomograms cannot replace clinical judgment when determining empiric vancomycin regimens for patients, vancomycin nomograms may still be appropriate for select patient populations.

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APPENDIX

Emory Healthcare Vancomycin Dosing Nomogram

Nomogram Instructions

1. Dose using total body weight.
2. Load with 20-25 mg/kg IV once (maximum dose 2500 mg).
3. Choose dosing Table A or B. Avoid Table A in patients with diabetes or who are receiving concomitant nephrotoxic agents.
4. Select dose based on patient's calculated creatinine clearance and total body weight.
5. Vancomycin trough concentration should be checked after 4 doses (inclusive of loading dose).

Table A. Goal trough 15 to 20 mg/L (age ≤55 years with stable renal function)

		Creatinine clearance, mL/min						
		40-49	50-59	60-69	70-79	80-89	90-99	≥100
Total body weight, kg	50-54	500 mg q 12h	750 mg q 12h	1000 mg q 12h	750 mg q 8h	1000 mg q 8h	1000 mg q 8h	1250 mg q 8h
	55-59	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	750 mg q 8h	1000 mg q 8h	1000 mg q 8h	1250 mg q 8h
	60-64	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	750 mg q 8h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h
	65-69	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1000 mg q 8h	1250 mg q 8h	1250 mg q 8h	1500 mg q 8h
	70-74	750 mg q 12h	1250 mg q 12h	750 mg q 8h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h	1500 mg q 8h
	75-79	1000 mg q 12h	1250 mg q 12h	750 mg q 8h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h
	80-84	1000 mg q 12h	1250 mg q 12h	1000 mg q 8h	1250 mg q 8h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h
	85-89	1000 mg q 12h	1500 mg q 12h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h
	90-94	1000 mg q 12h	1500 mg q 12h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h
	95-99	1250 mg q 12h	1500 mg q 12h	1000 mg q 8h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h
	100-104	1250 mg q 12h	1500 mg q 12h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h	2000 mg q 8h
	105-109	1250 mg q 12h	1500 mg q 12h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h	2250 mg q 8h
	≥110	1250 mg q 12h	1500 mg q 12h	1250 mg q 8h	1500 mg q 8h	1750 mg q 8h	2000 mg q 8h	2250 mg q 8h

Note: q 8h = every 8 hours; q 12h = every 12 hours.

Table B. Goal trough 15 to 20 mg/L (age >55 years, concomitant nephrotoxic agents)

		Creatinine clearance, mL/min							
		20-29	30-39	40-49	50-59	60-69	70-79	80-89	≥90
Total body weight, kg	35-39	500 mg q 24h	750 mg q 24h	750 mg q 24h	500 mg q 12h	500 mg q 12h	500 mg q 12h	750 mg q 12h	500 mg q 8h
	40-44	500 mg q 24h	750 mg q 24h	500 mg q 12h	500 mg q 12h	500 mg q 12h	750 mg q 12h	1000 mg q 12h	750 mg q 8h
	45-49	500 mg q 24h	750 mg q 24h	500 mg q 12h	500 mg q 12h	750 mg q 12h	750 mg q 12h	1000 mg q 12h	750 mg q 8h
	50-54	750 mg q 24h	750 mg q 24h	500 mg q 12h	750 mg q 12h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1000 mg q 8h
	55-59	750 mg q 24h	1000 mg q 24h	500 mg q 12h	750 mg q 12h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1000 mg q 8h
	60-64	750 mg q 24h	1000 mg q 24h	500 mg q 12h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1250 mg q 12h	1250 mg q 8h
	65-69	750 mg q 24h	1250 mg q 24h	500 mg q 12h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1250 mg q 8h
	70-74	1000 mg q 24 h	1250 mg q 24h	500 mg q 12h	1000 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1500 mg q 8h
	75-79	1000 mg q 24h	1250 mg q 24h	750 mg q 12h	1000 mg q 12h	1000 mg q 12h	1500 mg q 12h	1750 mg q 12h	1500 mg q 8h
	80-84	1000 mg q 24h	1500 mg q 24h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1700 mg q 12h	1500 mg q 8h
	85-89	1000 mg q 24h	1500 mg q 24h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	2000 mg q 12h	1750 mg q 8h
	90-94	1250 mg q 24h	1750 mg q 24h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	2000 mg q 12h	1750 mg q 8h
	95-99	1250 mg q 24h	1750 mg q 24h	750 mg q 12h	1250 mg q 12h	1500 mg q 12h	1750 mg q 12h	2000mg q 12h	1750mg q 8h
	100-104	1250 mg q 24h	1750 mg q 24h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1750 mg q 12h	2000 mg q 12h	2000 mg q 8h
	105-109	1250 mg q 24h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1750 mg q 12h	2000 mg q 12h	2000 mg q 8h
	110-114	1500 mg q 24h	750 mg q 12h	1000 mg q 12h	1250 mg q 12h	1500 mg q 12h	1750 mg q 12h	1250 mg q 8h	2000 mg q 8h
	115-119	1500 mg q 24h	750 mg q 12h	1000 mg q 12h	1500 mg q 12h	1500 mg q 12h	1750 mg q 12h	1250 mg q 8h	2000 mg q 8h
	≥120	1500 mg q 24h	750 mg q 12h	1000 mg q 12h	1500 mg q 12h	1750 mg q 12h	2000 mg q 12h	1500 mg q 8h	2000 mg q 8h

Note: q 8h = every 8 hours; q 12h = every 12 hours; q 24h = every 24 hours.