

CASE REPORTS

Unfractionated Heparin Dosing for Venous Thromboembolism in Morbidly Obese Patients: Case Report and Review of the Literature

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Unfractionated heparin infusion therapy is often administered using a weight-based dosing strategy for the treatment of venous thromboembolism. In the last several decades, the prevalence of obesity in the United States has increased significantly. The applicability of weight-based heparin dosing recommendations in the obese and morbidly obese population is uncertain, as limited data are available. We describe a 388-kg man who was started on an intravenous infusion of heparin according to hospital protocol for suspected pulmonary embolism. The patient was given a 5000-unit heparin bolus followed by an initial heparin infusion rate of 1500 units/hour, the maximum initial rate specified in the protocol. After additional infusion rate adjustments, a therapeutic activated partial thromboplastin time (aPTT) was reached 55 hours later with a heparin infusion rate of 3650 units/hour. Due to concerns of heparin-induced thrombocytopenia, heparin therapy was discontinued, and fondaparinux 5 mg/day was started. However, heparin therapy was restarted 4 days later for persistent, refractory hypoxemia and recurrent concerns of possible pulmonary embolism. During this second course, a therapeutic aPTT was achieved with a heparin infusion rate of 3550 units/hour. The patient developed bloody pulmonary secretions (with a therapeutic aPTT), necessitating the discontinuation of the heparin infusion. The patient later died after developing pulseless electrical activity. Standard weight-based heparin dosing protocols that specify maximum doses for initial bolus and infusion rates can result in significant delays in time to achieve therapeutic anticoagulation in the obese and morbidly obese patient. Despite limited data on heparin dosing in obesity, we recommend the use of a dosing weight to determine initial heparin dosing when treating venous thromboembolism in morbidly obese patients. It is reasonable to consider one of the following formulas: dosing weight = ideal body weight (IBW) + 0.3(actual body weight [ABW] – IBW), or dosing weight = IBW + 0.4(ABW – IBW).

Key Words: heparin dosing, obesity, venous thromboembolism, VTE, pulmonary embolism, PE.

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Unfractionated heparin has been used as a parenteral anticoagulant for over 50 years. Despite years of research and clinical experience, several controversies still remain regarding the optimal use of unfractionated heparin.¹ One such controversy is the recommended approach to heparin dosing for the obese patient. Weight-

based heparin dosing for venous thromboembolism (VTE) was introduced in 1993 and was found to result in an improvement in the time to achievement of therapeutic activated partial thromboplastin time (aPTT) when compared with standard dosing.² Subsequent studies documented improved clinical outcomes with the use of weight-based heparin protocols.³ The American College of Chest Physicians (ACCP) support the use of weight-based heparin dosing nomograms for VTE.⁴ The optimal dosing of other anticoagulants, such as low-molecular-weight heparins, in obesity has also received considerable attention and has recently been extensively reviewed.⁵

The volume of distribution for unfractionated heparin is similar to that of blood volume, 40–70 L/kg. Although obese patients have a larger blood volume, adipose tissue contains a lower blood volume than lean tissue.⁶ Heparin infusion rates based on actual body weight (ABW) may therefore provide too much heparin whereas infusion rates based on ideal body weight (IBW) could underestimate heparin requirements. Since the data to support the lower limit of the heparin therapeutic range are stronger than the data to support the upper limit,¹ a major concern for the obese patient is failing to exceed the lower limit of the heparin therapeutic range (i.e., under-dosing). In the United States, there is an increasing trend of obesity. In 2008, two thirds of states reported a prevalence of obesity of 25% or higher.⁷ As a result of this trend, clinicians are frequently challenged with the identification of appropriate dosing strategies.⁷ The application of weight-based heparin dosing strategies may result in initial doses that exceed the upper limit of the therapeutic range. The recent increase in focus on anticoagulant safety may increase physician apprehension in using weight-based heparin dosing strategies in obese and morbidly obese populations due to fear of increased bleeding.^{8–10}

A search of the MEDLINE (1960–2009) and International Pharmaceutical Abstracts (1970–2009) databases was performed using the following terms: unfractionated heparin, heparin, obesity, morbid obesity, and venous thromboembolism. A variety of case reports and retrospective studies were identified.^{11–18} References of the articles were reviewed to identify additional literature. The variability in the weight evaluated—ABW versus dosing weight (DW)—and in the definition of obesity used limits the ability to draw a definitive

recommendation on the best approach. The World Health Organization (WHO) uses body mass index (BMI) to characterize obesity. A BMI of 25–29.9 kg/m² is classified as overweight, 30–34.9 kg/m² as moderate obesity, 35–39.9 kg/m² as severe obesity, and 40 kg/m² or greater as morbid obesity.¹⁹ Further modifications have been made to the WHO obesity definitions in the surgical literature, where morbid obesity is divided into additional categories: a BMI of 40–49.9 kg/m² is morbid obesity, and 50 kg/m² or greater is super obese.²⁰

Very limited data are available on heparin dosing in the morbidly obese patient. We describe our experience with heparin dosing in a morbidly obese (using the WHO definition) or super obese (using the surgical literature) critically ill patient.

Case Report

A 32-year-old, 388-kg (height 5'7", IBW 66.1 kg, BMI 134 kg/m²) man came to the emergency department with complaints of intermittent cough and progressively worsening chest pain and shortness of breath for the past 9 days. The family reported that the patient had experienced a fall before coming to the emergency department, without subsequent trauma or pain. The patient's medical history was significant for morbid obesity, obstructive sleep apnea requiring continuous positive airway pressure (patient was noncompliant), probable chronic obstructive pulmonary disease, venous stasis, hypoventilation, and chronic lower extremity cellulitis. The patient's surgical history included bilateral lower extremity plastic surgery 6 years earlier during which more than 32 kg of adipose tissue was removed. He was taking cephalexin on a long-term basis for cellulitis. He had no other drug therapy and no known drug allergies. The patient had a 60-pack-year history of tobacco use, occasionally drank alcohol, and used cocaine in the past. His family history was unremarkable.

The patient's vital signs were a blood pressure of 138/102 mm Hg, pulse 60 beats/minute, respiratory rate 26 breaths/minute, and temperature 37.5°C. He was noted to have bilateral leg swelling, and a lung examination revealed wheezes and rhonchi bilaterally. The remainder of his physical examination was unremarkable. A chest radiograph demonstrated bilateral air space disease and possible vascular congestion. Arterial blood gases were as follows: pH 7.26

(normal range 7.35–7.45), partial pressure of carbon dioxide (pCO₂) 94 mm Hg (35–45 mm Hg), partial pressure of oxygen (pO₂) 59 mm Hg (80–100 mm Hg), bicarbonate 41 mEq/L (23–29 mEq/L), and an oxygen saturation of 80% (95–98%) on 3 L of oxygen. The patient responded poorly to a trial of bilevel positive airway pressure with repeat arterial blood gases of pH 7.16, pCO₂ 128 mm Hg, pO₂ 96 mm Hg, and bicarbonate 43 mEq/L. The patient was subsequently intubated and admitted for acute respiratory failure secondary to obesity hypoventilation syndrome. Although the clinical suspicion of pulmonary embolism was low (Wells score of zero),²¹ a quantitative D-dimer, bilateral lower extremity venous Doppler examination, and a ventilation-perfusion scan were ordered. Computed tomography could not be performed due to the patient's body habitus.

The patient was started empirically on heparin infusion therapy. The heparin protocol used in the hospital did not specify a weight-based bolus dose but did specify a weight-based initial infusion rate of approximately 15 units/kg/hour. The maximum initial empiric heparin infusion rate specified in the protocol was 1500 units/hour. The target aPTT therapeutic range was 55–89 seconds, which corresponds to a heparin antifactor Xa level of 0.3–0.7 units/ml (according to the ACCP guidelines).⁴ The patient was initially given a 5000-unit bolus (12.9 units/kg ABW) followed by an infusion at 1500 units/hour (3.9 units/kg ABW/hr). After 7 hours, the patient's aPTT was 27 seconds. Despite additional incremental bolus dosing of heparin and adjustments in the infusion rate, the aPTT remained subtherapeutic (Figure 1). At hour 24, in response to an aPTT of 29.4 seconds, the patient's heparin infusion rate was increased to 3000 units/hour (7.7 units/kg ABW/hr). After

additional infusion rate adjustments, the first therapeutic aPTT was achieved 55 hours after initiation at a rate of 3650 units/hour (9.4 units/kg ABW/hr). At this time, the quantitative D-dimer (latex agglutination method) was negative at 460 ng/ml fibrinogen equivalent units. The lower extremity Doppler examination was also negative. A transthoracic echocardiogram revealed chronic cor pulmonale, mild-to-moderate pulmonary hypertension, mild concentric left ventricular hypertrophy, preserved systolic function, and no evidence of thrombus. The ventilation-perfusion scan was limited; however, no definitive evidence of pulmonary embolism was demonstrated.

On hospital day 6, the heparin infusion was discontinued due to concerns of heparin-induced thrombocytopenia; the patient's platelet count was 122 x 10³/mm³, representing a greater than 50% decrease from his admission platelet count. Intermediate-dose fondaparinux (5 mg/day) was started for VTE prophylaxis. The heparin-platelet factor 4 antibody was negative (optical density 0.148; PF4 Enhanced, GTI Diagnostics, Waukesha, WI), and subcutaneous heparin 5000 units every 8 hours was started for VTE prophylaxis.

Despite treatment with broad-spectrum antibiotics, corticosteroids, and bronchodilators, the patient's oxygenation failed to improve. On hospital day 10, heparin therapy was empirically restarted for suspicion of pulmonary embolism due to persistent, refractory hypoxemia. An initial bolus of 10,000 units (25.8 units/kg ABW) was given followed by an initial infusion rate of 3000 units/hour (7.7 units/kg ABW/hr). The infusion rate was subsequently increased to 3550 units/hour (9.1 units/kg ABW/hr), which resulted in a therapeutic aPTT 48 hours later (Figure 1). On day 14, the patient developed

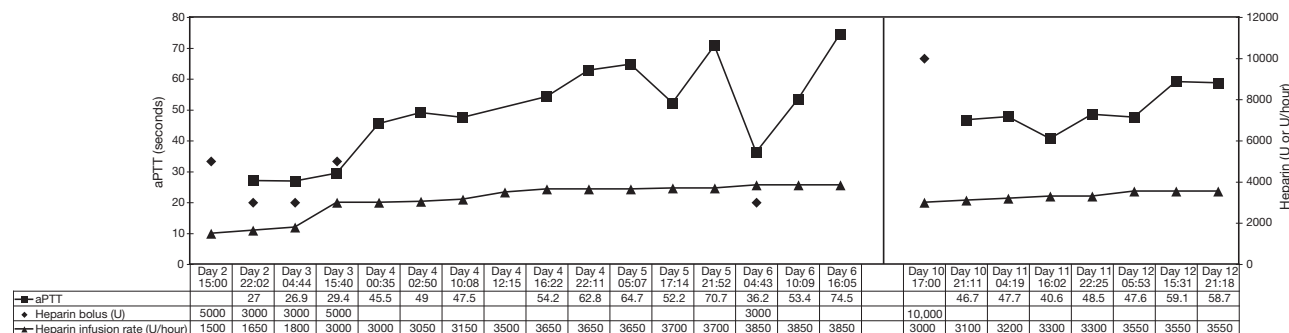


Figure 1. Timeline of heparin dosing in the 388-kg patient and the corresponding activated partial thromboplastin time (aPTT) values from hospital days 2–12. The institution's therapeutic range for aPTT was 55–89 seconds.

refractory hypotension requiring vasopressor therapy. The heparin infusion was discontinued that morning due to the development of bloody pulmonary secretions (aPTT 58.7 sec). Despite maximum supportive care, later that day the patient became progressively more hypoxic and hypotensive and developed pulseless electrical activity. Advanced cardiac life support was initiated, and although initially the patient regained a pulse, he subsequently reverted back to pulseless electrical activity and died.

Discussion

Reports from the Centers for Disease Control and Prevention and Behavioral Risk Factor Surveillance System indicate an increasing trend of obesity (BMI > 30 kg/m²) in the United States.⁷ The implications of the worsening obesity epidemic in health care are numerous but include difficulties in determining drug dosing for heparin and many other drugs. The correct initial heparin dose impacts the time to achieve therapeutic anticoagulation. Achieving therapeutic anticoagulation within 24 hours of starting an intravenous heparin infusion for VTE is associated with decreased occurrence of recurrent thromboembolism.^{2, 22} The use of a standard heparin infusion rate of 1000 units/hour has been shown to be ineffective, especially in the obese patient, and can delay the time to achieve a therapeutic anticoagulant effect.¹² The clinical outcomes of applying a weight-based heparin dosing nomogram to the obese and morbidly obese populations are unclear, as very few overweight patients were originally studied (nine patients weighed more than 100 kg [range 101–131 kg]).² Limited data suggest that the use of ABW in a weight-based nomogram can result in suprathreshold anticoagulation due to overestimation of the heparin volume of distribution.^{11, 13}

The aPTT values were retrospectively evaluated in 63 non-morbidly obese (mean ABW 97 kg, mean BMI 31 kg/m²) and 38 morbidly obese (mean ABW 151 kg, highest ABW 263 kg, mean BMI 52.5 kg/m²) patients being treated for VTE.¹¹ All patients received a heparin 80-unit/kg bolus followed by an 18-unit/kg/hour infusion rate calculated using ABW with no maximum dose limit. The institution-specific therapeutic range was an aPTT of 70–110 seconds. The resulting average aPTT values at 6 hours and 12 hours after starting heparin were significantly greater in the morbidly obese group versus those

in the non-morbidly obese group: 155 seconds vs 135 seconds at 6 hours ($p=0.02$) and 141 seconds vs 117 seconds at 12 hours ($p=0.012$). At 12 hours, there were significantly more morbidly obese patients with a suprathreshold aPTT than in the non-morbidly obese group (71% vs 43%, $p=0.006$) and more patients overall with a suprathreshold aPTT than with a therapeutic aPTT ($p=0.012$). Despite the increase in suprathreshold aPTT results, none of the patients in the morbidly obese group suffered major bleeding, which was defined as a decrease in hemoglobin of 2 g/dl plus overt bleeding or a transfusion of at least 2 units of packed red blood cells within 48 hours of heparin initiation. This study demonstrated that in obese and morbidly obese patients, the use of ABW for initial heparin dosing without initial maximum doses specified results in increasingly greater aPTT values and greater risk of suprathreshold anticoagulation as body weight increases.

The outcome of weight-based heparin dosing (80-unit/kg bolus and 18-unit/kg/hour infusion using ABW) was described in a morbidly obese (255-kg) woman with suspected pulmonary embolism.¹³ A 20,400-unit (80-unit/kg) heparin bolus followed by a 4590-unit/hour infusion (18-unit/kg/hr) was initiated. After 6 hours, the aPTT was above 150 seconds and persisted for more than 24 hours despite dose reductions. The final average infusion rate to maintain a therapeutic aPTT was less than 1280 units/hour (~5 units/kg ABW/hr). This case demonstrates the potential risk of overanticoagulation when ABW is used to determine initial heparin dose requirements in a morbidly obese patient.

A retrospective medical record review of obese patients (> 50% above IBW) in one institution who received initial weight-based heparin dosing after a protocol change for obese patients from a rate of 18 units/kg/hour to 15 units/kg/hour based on ABW has been reported.¹⁴ The institution imposed a 10,000-unit maximum on the heparin bolus dose and a 2100-unit/hour maximum for the initial infusion rate. The majority of patients received heparin for VTE treatment. Data from obese patients were compared with nonobese patients in whom heparin was started at 18 units/kg/hour. Patients in both groups received a heparin bolus of 80 units/kg. Only 10 (18.9%) of 53 patients evaluated were obese whereas 16 patients (30.2%) were 30–50% above IBW. The median \pm SD time to achieve a therapeutic aPTT was not

significantly different between obese and nonobese patients: 27.8 ± 27 hours and 31 ± 20.8 hours, respectively. At 6 hours, however, a supratherapeutic aPTT was reported in 80% of patients in the obese group and in 93.7% of patients who were 30–50% above IBW. These data suggest that the use of an 80-unit/kg bolus followed by a reduced infusion rate of 15 units/kg/hour based on ABW in obese patients can result in overanticoagulation. Unfortunately, detailed information regarding patients' weight was not provided. None of the obese patients suffered minor or major bleeding. Major bleeding was defined as symptomatic bleeding in major organs, fatal bleeding, or a decrease in hemoglobin level requiring a transfusion of at least 2 units of red blood cells. Patients weighing 30–50% above their IBW also demonstrated overanticoagulation without an increased risk of major bleeding using standard weight-based heparin dosing.

A retrospective medical record review in 40 obese ($ABW > IBW + 30\%$ [20 patients]) and nonobese ($ABW \leq 20\%$ above IBW [20 patients]) patients who had received heparin at an acute care hospital has been described.¹⁵ The indication for heparin therapy was not provided. The heparin dosing protocol recommended a 70-unit/kg bolus, followed by an infusion of 15 units/kg/hour based on ABW with no maximum doses specified. No significant differences were noted in the obese versus nonobese groups in mean time to first therapeutic aPTT (25.9 hrs vs 25.2 hrs), mean final heparin infusion rate (12.9 units/kg/hr vs 12.4 units/kg/hr), and proportion of patients reaching target aPTT within 24 hours (45% vs 60%). At 24 hours, 45% of patients in the obese group had supratherapeutic aPTTs compared with 35% in the nonobese group. The average patient weight in the obese group was 95 kg, with only six patients exceeding 100 kg. The authors concluded that ABW is appropriate to use in a heparin weight-based protocol in obese patients. This global recommendation, however, may not be applicable to the morbidly obese population, due to the mild level of obesity of patients included in the study and use of a reduced initial heparin infusion rate (15 units/kg/hr as opposed to 18 units/kg/hr).

Although some data are present to support concerns with using ABW for heparin dosing in the obese or morbidly obese, there are also concerns with the use of IBW. The use of IBW may result in underestimation of heparin requirements since this method does not give

consideration to the blood volume of adipose tissue. As a result of these concerns with both ABW and IBW in heparin dosing, alternative strategies that employ DW have been evaluated.

A retrospective review of weight-based heparin dosing has been reported for 213 obese (> 10 kg above IBW) and nonobese patients.¹⁶ Indications for heparin were VTE (42.7%), unstable angina or percutaneous transluminal coronary angioplasty (21.1%), transient ischemic attack or stroke (19.3%), acute myocardial infarction (15.5%), and others (1.4%). Heparin was administered using an 80-unit/kg bolus and initial intravenous infusion rate of 18 units/kg/hour calculated using ABW. In obese patients, DW was used and calculated as $IBW + 0.3(ABW - IBW)$. Of the patients evaluated, 124 met the definition of obese and 26 weighed above 100 kg (maximum weight 184 kg). The heparin infusion rate resulting in a therapeutic aPTT for each patient was noted. Using the known therapeutic infusion rate, the use of IBW, ABW and DW were compared by evaluating the range (20–80th percentile) of calculated infusion rates with each body weight for obese and nonobese patients. Initial aPTT values were also compared. The initial aPTT was supratherapeutic in both groups; however, the value in the obese group was significantly lower than that in the nonobese group (mean \pm SD 98 ± 65 sec vs 132 ± 93 sec). Statistically significant differences in calculated heparin infusion rates in the obese group were noted across body weights whereas this was not true for the nonobese group. In obese patients, use of ABW resulted in the smallest difference (4 units/kg/hr) between the 20th percentile infusion rates and 80th percentile infusion rates. The 50th percentile infusion rate in the obese group using the DW was 15 units/kg/hour compared with 12 units/kg/hour based on ABW. The authors reported that the use of ABW with an initial infusion rate of 15 units/kg/hour would have resulted in a therapeutic aPTT in 80% of patients evaluated (data not shown). Based on these data, the authors recommended using an initial bolus of 80 units/kg and infusion rate of 15 units/kg/hour based on ABW, with a maximum initial bolus and infusion rate of 10,000 units and 1500 units/hour, respectively, to avoid potentially overdosing morbidly obese patients.

A case report of a 54-year-old morbidly obese (182.4 kg, BMI 75 kg/m²) woman treated with heparin for a highly probable pulmonary embolism described the use of a modified DW

(average of IBW and ABW) of 120 kg to calculate the heparin bolus (80 units/kg [9600 units]) and initial infusion rate (18 units/kg/hr [2160 units/hr]).¹⁷ A therapeutic aPTT (target range 70–115 sec; equivalent to a heparin concentration of 0.3–0.7 units/ml) was achieved in this patient within 10 hours with the initial infusion rate of 2160 units/hour. The heparin aPTT was maintained at the higher end (94.7–116.9 sec) of the target aPTT range (70–115 sec) for the duration of therapy (6 days). The author recommended consideration of a modified DW for heparin dosing in the obese population. A concern was expressed for potential overanticoagulation when ABW is used in obese patients.

Results of a retrospective medical record review of eight obese (BMI > 29 kg/m²) patients receiving heparin for pulmonary embolism were described.¹⁸ Although their hospital guidelines specified determination of the heparin bolus dose and initial infusion rate using an ABW-based nomogram, the nomogram was not used in these patients. The average heparin infusion rate to maintain a therapeutic aPTT (60–90 sec) was 12.8 units/kg/hour (range 8.4–15.8 units/kg/hr). The authors reported that this average dose was 40% of the difference between the dose calculated based on IBW and ABW, and concluded that although this heparin dosing strategy (DW = IBW + 0.4[ABW – IBW]) may reflect the optimal one in obese patients, confirmation with a larger sample size study is needed.

Our case report provides information on heparin dosing in a 388-kg patient, which is over 120 kg more than the heaviest person we identified in the literature (one study included a 263-kg patient⁸). Our patient's heparin therapy was initiated using a bolus of 5000 units (12.9 units/kg ABW) and the maximum initial infusion rate specified according to institutional protocol, 1500 units/hour (3.9 units/kg ABW/hr). At our institution, nurses manage heparin therapy using a nomogram. The infusion of 1500 units/hour resulted in subtherapeutic anticoagulation. A DW¹⁶ was used to calculate the new infusion rate of 3000 units/hour (15.4 units/kg DW/hr or 7.7 units/kg ABW/hr), which resulted in an increase in the aPTT; however, it remained subtherapeutic. Therapeutic anticoagulation was achieved after four subsequent dosage adjustments, resulting in an infusion rate of 3650 units/hour (9.4 units/kg/hr). This rate is approximately 20% higher than the infusion rate calculated using the DW formula.¹³ A second course of heparin was initiated with a 10,000-unit bolus (25.7

units/kg), followed by an infusion of 3000 units/hour (7.7 units/kg ABW/hr), which resulted in subtherapeutic anticoagulation. Therapeutic anticoagulation was achieved after the infusion rate was increased to 3550 units/hour (9.1 units/kg ABW/hr).

Several dosing schemes have been described for determining initial heparin dosing in obese and morbidly obese patients. Application of these schemes to our patient resulted in a wide range of initial heparin infusion rates: 1190–6984 units/hour (Table 1). Although several DW equations exist, data evaluating the appropriateness of different DWs in obese and morbidly obese patients are not available. In our patient, despite increasing the infusion rate using one of the proposed DW strategies (DW = IBW + 0.3[ABW – IBW]¹⁶), a prolonged period of subtherapeutic anticoagulation occurred. This may suggest that the use of this DW strategy is inadequate for calculating heparin requirements in the morbidly obese. The final heparin infusion rate resulting in therapeutic anticoagulation in our morbidly obese patient more closely resembled that predicted using a different DW strategy (DW = IBW + 0.4[ABW – IBW]¹⁵). If we had chosen this DW strategy, it is likely that the time to achieve therapeutic anticoagulation would have been reduced.

The maximum initial heparin infusion rate for treatment of VTE at our institution resulted in an inappropriately conservative initial infusion rate for our morbidly obese patient. Institutions with maximum initial heparin rates for treatment of VTE (with the intention of avoiding overanticoagulation in obese patients) are encouraged to develop a special provision for initial dosing in morbid obesity, as limitations on initial infusion rates may greatly increase time to achievement of therapeutic anticoagulation in this population. Provisions should include contacting a clinical pharmacist for individualized dosing; if the pharmacist is unavailable, the use of a DW for calculating the initial heparin infusion rate should be considered. It is also important to note that the nomogram used to adjust the heparin infusion rate may not apply in a morbidly obese patient. The recommended incremental dose change (upward or downward) may be insufficient in patients with very high infusion rates (such as 3000 units/hr in our patient).

Although it is clear that weight-based heparin dosing can improve the time required to achieve therapeutic anticoagulation, data are limited that

Table 1. Application of Various Heparin Dosing Strategies in a Morbidly Obese, 388-kg Patient^a

Dosing Method	Regimen	Patient's Results
IBW ¹⁶		
Bolus dose	80 units/kg	5288 units
Initial infusion rate	18 units/kg/hr	1190 units/hr
ABW with maximum doses specified ¹⁶		
Bolus dose	80 units/kg (maximum 10,000 units)	10,000 units
Initial infusion rate	15 units/kg/hr (maximum 1500 units/hr)	1500 units/hr
ABW with maximum doses specified ¹⁴ (used if ABW > 30% above IBW)		
Bolus dose	80 units/kg (maximum 10,000 units)	10,000 units
Infusion rate	15 units/kg/hr (maximum 2100 units/hr)	2100 units/hr
DW equations		
DW = IBW + 0.3(ABW – IBW) ¹⁶ (used if ABW > [IBW + 10 kg])		66.1 kg + 0.3(388 kg – 66.1 kg) = 163 kg
Bolus dose	80 units/kg	13,040 units
Infusion rate	18 units/kg/hr	2934 units/hr
DW = IBW + 0.4(ABW – IBW) ¹⁸		66.1 kg + 0.4(388 kg – 66.1 kg) = 195 kg
Bolus dose	80 units/kg	15,600 units
Infusion rate	18 units/kg/hr	3510 units/hr
Modified DW = (ABW + IBW)/2 ¹⁷		(388 kg + 66.1 kg)/2 = 227 kg
Bolus dose	80 units/kg	18,160 units
Infusion rate	18 units/kg/hr	4086 units/hr
ABW ¹⁵		
Bolus dose	70 units/kg	27,160 units
Initial infusion rate	15 units/kg/hr	5820 units/hr
ABW ^{2, 11, 13}		
Bolus dose	80 units/kg	31,040 units
Infusion rate	18 units/kg/hr	6984 units/hr

IBW = ideal body weight; ABW = actual body weight; DW = dosing weight.

^aIBW = 66.1 kg.

support the optimal weight for heparin dosing in obese and morbidly obese patients with VTE. In the data from the case reports and small studies we reviewed, the authors used different definitions of obesity, different dosing schemes, and different calculations for determining DW. Although the obese and morbidly obese population in the United States continues to grow, the inconsistencies in the available data impede health care professionals from readily determining optimal heparin dosing in this population. A larger scale, randomized, prospective study, or observational or retrospective studies are needed to determine the optimal dosing weight for heparin in morbidly obese patients with VTE.

Conclusion

Our heparin dosing experience in a patient with suspected pulmonary embolism was in one of the heaviest patients reported in the literature (388 kg). The available evidence demonstrates that the use of IBW or ABW for determining heparin doses in the morbidly obese population

will most likely result in underdosing or overdosing, respectively. Although several dosing schemes and calculations for determining DW in obese and morbidly obese patients exist, a weight-based dosing scheme using a modified DW (DW = IBW + 0.4[ABW – IBW]) may have been most effective in rapidly achieving therapeutic anticoagulation and corresponding infusion rate requirements in our patient. After reviewing the available literature, we recommend the use of a DW to determine initial heparin dosing in morbidly obese patients with VTE. Although the data are limited, we feel it is reasonable to consider one of the following formulas: DW = IBW + 0.3(ABW – IBW), or DW = IBW + 0.4(ABW – IBW).

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