International Journal of Research in Medical Sciences
Patel DM et al. Int J Res Med Sci. 2019 Feb;7(2):334-340
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20190330

Original Research Article

Efficacy and superiority of an innovative method (IM) of intravenous (IV) fluid drip drop rate calculation using IV set and its comparison with conventional methods (CM)

Dhruvkumar M. Patel[1], Mukundkumar V. Patel[2]*, Kamal H. Sharma[3], Jignesh C. Kaklotar[4], Greshaben R. Patel[5], Maitri M. Patel[6]

[1]MBBS Student, Smt. N.H.L. Municipal Medical College, Ahmedabad, Gujarat, India
[2]Department of Medicine, Zydus Medical College and Hospital, Dahod, Gujarat, India
[3]Department of Cardiology, U.N. Mehta Institute of Cardiology, Civil Hospital, Ahmedabad, India
[4]Department of Medicine, Tvter State Medical University, Russia
[5]Intern MBBS Student, B. J. Medical College, Ahmedabad, Gujarat, India
[6]UG Medical student, GCS Medical College, Ahmedabad, Gujarat, India

Received: 21 November 2018
Accepted: 29 December 2018

***Correspondence:**
Dr. Mukundkumar V. Patel,
E-mail: drmukundvpatel123@yahoo.co.in

ABSTRACT

Background: Almost every indoor patient requires some form of intravenous (IV) fluids and its infusion rate should be proper as recommended for best treatment outcomes. To overcome the same, a simple, quick and easily applicable new method for drip drop rate calculation is proposed, which is user-friendly at bedside and doesn't require mathematical skills or help.
Methods: Author compared this novel innovative method (IM) of IV fluid drip drop rate method for both regular macro and micro drop infusion set against conventional mathematical calculation method (MC) of infusion in various IV fluid indoor orders and assessed for time-to-initiation of treatment (TI) required and its accuracy. Ten resident doctors and ten nursing staff participated to grade both conventional and novel methods by using pre-printed forms of various parameters like time consumption, comfort level, accuracy and applicability in ward and these both methods were scored on a scale of 1 to 10.
Results: Conventional method (CM) required 14.23±1.10seconds, while novel method (IM) required average 3.63±0.73seconds for calculation of drop rate. Average grading for conventional method was 3.63±0.49 and for novel method was 7.84±0.6 out of 10.
Conclusions: Novel method of IV fluid drip drop rate formula is easy, quick and superior in comparison to conventional method and it doesn't require any additional instrumental help. It is good alternative to conventional formula for IV drip drop rate calculation in absence of infusion pump.

Keywords: Conventional method, Comparison, IV fluid drip micro drop, IV fluid drip drop rate calculation, IV fluid drip regular drop, Novel innovative method

INTRODUCTION

Intravenous (IV) fluids are routinely used in indoor treatment of almost all patients. IV fluids are required for volume replacement or as vehicle to transfuse parenteral drugs. Administration of IV fluids should be done with proper rate because too slow or too fast infusion leads to unwanted serious consequences.[1,2] Commonly used IV

fluids are crystalloids (normal saline, ringer lactate, 5% dextrose) and colloids (Haemaccel, dextran 40, 5% Albumin). Crystalloid IV fluids are isotonic (normal saline, ringer lactate), hypotonic (0.45 normal saline) or hypertonic (25% dextrose).[3,4] Often IV fluid orders are not written in drop rate per minute but instead it is left for the doctor or nursing staff on duty to calculate the rate of infusion. E.g. Injection normal saline 100ml/hour till further order or injection normal saline 500ml IV over six hours. These types of IV fluid medication orders are not only difficult to execute when infusion pumps are not available at bedside but drop rate calculation by conventional methods is also required which can lead to erroneous dosage being administered to the patient and this could be catastrophic. Routinely two types of IV sets are used for infusion treatment. Regular drop IV set deliver 16 drops per ml and micro drop IV set deliver 60 drops per ml.

Conventional IV fluid drip drop calculation method (CM) is complex, time consuming and require calculator or medical applications to calculate the dosage.[5] Infusion pumps are ideal for perfect drop rate delivery but are costly and may not be available at all indoor beds. Conventionally, resident doctors, medical students and nursing staff use CM for drip drop rate calculation as elucidated below.[4]

Regular (CM) IV set drop rate calculation per minute: First convert amount of infusion fluid per minute and then multiply with 16. Drop rate/minute=volume of fluid/Time duration x drop factor (16).

Micro drop IV set drop rate calculation per minute: First convert amount of fluid per minute and then multiply with 60. Drop rate/minute=volume of fluid/Time duration x drop factor (60).

Nurses and doctors should know exact drop rate calculation for writing and executing IV fluid treatment orders. In developing countries, nurse patient ratio and doctor patient ratio are not ideal. The medical staffs end up treating a greater number of patients in comparison to Western countries per day. The study proposes an easy and quick drip drop rate formula (IM) to make this task simple and one which can be applied without use of calculator in absence of infusion pump. This new method (IM) is very useful in emergency situations like temporarily set up hospitals as set during wars and natural calamities. In case of electricity failure or when infusion pump is out of order, this new method can come handy. The aim of present study was to compare this newly proposed formula (IM) of IV fluid drip drop rate calculation with conventional formulas and to check their accuracy and practical applicability.

METHODS

This was a randomized, prospective, open label study amongst participating resident doctors and nursing staff involved in calculating the dose to study time to calculation and efficacy of the novel innovative method (IM) for regular drop and micro drop drip rate calculation for various IV fluid orders as compared to conventional method. Zydus Medical College and Hospital, Dahod from July 2018 to August 2018. Author also assessed the user friendliness of both methods using a grading for them. Each participant was asked to calculate the tasks using both the methods for 2 different scenarios and hence the individual variability at mathematical and logical skills was minimized.

Regular drop (16 drop per minute) rate calculation method

(A-I) 24-hour dose method

First convert the dose amount in millilitre of fluid to be infused in 24 hours and then divide it with one hundred. Add one factor of every ten of this answer and this was drop rate per minute.

(A-II) One-hour dose method

Find out amount of fluid per hour dose (ml) and then dividing it by four gives the drop rate per minute.

Micro drop rate/minute calculation method

Find out amount of fluid dose per hour and that was the drop rate per minute. Author compared various IV fluid indoor orders by conventional method and invented methods to assess time required to calculate drop rate for initiation of treatment either manually or with help of calculator and accuracy of new methods in reference to conventional method. Invented methods for regular drop rate calculation are two, 24hour dose method (A-I) and one-hour dose method (A-II). Either of the method was allowed to be used by participant if they were randomized to novel method (IM), by which oral calculation was presumed to be easy for that particular IV fluid orders by the participant. For example, if 300ml fluid infusion over 2hours duration, one-hour dose method was easy and for 500ml fluid infusion over six hours, 24hour dose method was easy for calculation. Micro drop rate was calculated using method B. User friendliness of both the methods was assessed using a predetermined feedback form (Annexure) to compare both the innovative and conventional method. Innovative (IM) and conventional (CM) methods were explained to ten resident doctors and ten nursing staff volunteers. Each participant completed two tasks in totality with one task each using either of the methods. They were also requested to compare and opine conventional and invented method for different IV fluid orders. Mathematical complexity, time to initiation of treatment, comfort level, bed side applicability and accuracy was assessed for each method. Sample forms were filled by volunteers and rating was given to both methods. Mean time required for initiation of treatment was compared

with conventional method using manually or with the use of calculator and by software base apps.

The time was measured in seconds using stopwatch. Statistical analysis was performed using SPSS, Version 22.0 (Chicago, IL, USA). Continuous variables were expressed as mean±SD.

RESULTS

Table 1 shows regular IV infusion set (1ml=16 drops) drop rate calculation by one-hour dose method AII, 24hr dose method AI and by conventional method for various amount of IV fluid infusion starting from 20ml to 3000ml for different durations starting from 60minutes to 24hours.

Table 1: Innovative method (A-I and A-II) and its comparison with conventional method.

Fluid dose (ml)	Time duration of dose (min)	Regular drops/minute conventional	Regular drop 1hr dose invented method AII	Regular drop 24hr dose invented method AI	Time for reg drop conventional manually (sec)	Time for regular drop invented method manually	Time for reg drop conventional calculator (sec)	Time for drop rate by app (sec)
20	60	5	5	5	12.5	2.5	13.5	14.4
24	60	6	6	6	13.5	2.8	14.5	13.6
30	60	8	8	8	14.5	3.2	12.8	14.2
36	60	10	9	10	12.2	3.5	12.5	12.2
40	60	11	10	11	16.5	3.4	14.6	14.3
48	60	13	12	13	14.8	4.0	13.6	15.4
50	60	13	13	13	11.8	2.6	14.5	14.5
52	60	14	13	14	16.6	4.8	15.5	15.6
60	60	16	15	16	11.5	2.6	12.5	14.6
66	60	18	17	17	16.5	4.2	15.6	16.5
70	60	19	18	18	14.5	3.2	14.8	14.3
77	60	21	19	20	12.8	4.6	13.2	12.2
80	60	21	20	21	15.5	2.9	16.2	14.8
85	60	23	21	22	14.8	3.8	15.5	15.6
90	60	24	23	24	13.2	2.8	13.8	14.4
95	60	25	24	25	16.2	4.2	16.4	13.2
100	60	27	25	26	12.5	2.2	14.6	14.6
110	60	29	28	29	13.8	2.4	15.5	12.2
120	60	32	30	32	12.5	2.6	12.8	14.2
130	60	35	33	34	11.2	3.2	13.2	15.4
140	60	37	35	37	12.4	3.4	13.5	14.6
150	60	40	38	40	13.2	3.8	14.2	15.6
160	60	43	40	42	13.5	4.2	14.6	14.4
170	60	45	43	45	14.2	3.5	15.0	16.2
180	60	48	45	48	14.6	3.8	15.2	14.2
190	60	51	48	50	13.5	4.2	13.6	12.2
200	60	53	50	53	12.5	3.2	13.4	13.4
300	60	80	75	79	11.8	3.2	12.5	14.6
400	60	107	100	106	12.2	3.6	13.5	15.2
500	60	133	125	132	12.4	3.6	13.5	16.2
500	120	67	63	66	13.2	4.2	14.5	14.4
500	180	44	42	44	13.2	4.6	12.5	15.8
500	240	33	31	33	14.5	4.2	13.6	12.6
500	360	22	21	22	16.2	4.6	15.5	13.4
500	480	17	16	17	16.8	4.5	14.5	14.8
1000	120	133	125	132	16.5	4.2	13.5	13.6
1000	240	67	63	66	14.5	4.6	15.2	15.6
2000	180	178	167	176	13.5	3.8	14.5	12.2
3000	480	100	94	99	15.6	4.8	16.2	15.6
3000	1440	33	31	33	16.2	3.6	14.5	14.2

Table 2: Micro drop method (B) comparison with conventional method.

Fluid (ml) dose	Infusion time (min) duration of dose	Micro drop rate per min conventional	Invented formula B micro drop/min	Time for conventional micro drop manually (sec)	Time for micro drop invented method manually	Time for micro drop conventional calculator (sec)	Time for drop rate by app in seconds
5	60	5	5	15.5	2.6	15.5	14.2
10	60	10	10	14.8	3.2	13.4	16.6
13	60	13	13	15.8	4.2	14.6	15.4
20	60	20	20	14.6	2.8	15.8	14.6
24	60	24	24	14.8	3.2	16.2	13.3
30	60	30	30	15.2	3.4	15.4	14.8
36	60	36	36	16.8	3.8	13.6	13.6
40	60	40	40	15.5	2.8	14.5	15.2
48	60	48	48	16.8	3.6	15.6	14.4
50	60	50	50	14.6	3.2	12.8	15.6
52	60	52	52	16.2	3.6	16.2	14.8.
60	60	60	60	12.8	2.6	15.4	14.6
66	60	66	66	15.2	4.2	14.6	15.5
70	60	70	70	13.8	3.8	15.4	14.4
77	60	77	77	16.4	4.2	13.6	13.6
80	60	80	80	12.6	2.6	15.5	15.2
85	60	85	85	15.8	3.8	14.8	14.6
90	60	90	90	12.5	3.4	15.2	12.4
95	60	95	95	16.5	4.2	16.4	15.2
100	60	100	100	12.8	2.8	14.5	14.4

It also demonstrates time required to calculate drop rate by invented methods (AI and AII) for regular drop IV drip, regular drip drop rate calculation by conventional method by using calculator and by software base app method.

Table 2 shows micro drop drip rate (1ml=60drop) calculation comparison for various IV fluid dose over 60minutes time by invented method B and by conventional method for various amount of IV fluid infusion starting from 5-100ml.

It also demonstrates time required to calculate drop rate for micro drop IV drip by invented method by conventional method by using calculator and by soft were base app method for different doses.

Table 3 shows rating of invented and conventional methods with the help of various parameters like mathematical complexity, speed of using method, comfort level of using particular method, accuracy of various methods, practical applicability of using particular method in ICU or ward, strong or weak recommendation regarding various methods for colleagues, overall grading of the methods and average time required in seconds for execution of IV indoor prescriptions by ten doctors (D1 to D10) and ten nursing staff (N1 to N10) volunteers. Regular drop as well as micro drop rate calculation by invented method takes 3.63±0.73 and 3.4±0.57 seconds, while conventional method takes about 14.23±1.10 and 14.95±0.99seconds respectively. Average grading for conventional method was 3.63±0.49 and for invented method it was 7.84±0.6 out of 10.

DISCUSSION

IV fluids therapy management is corner stone in all indoor treatment in all hospital departments and from wards to intensive care units.

Medical emergencies like shock, diabetic ketoacidosis, hypoglycemia, acute meningoencephalitis syndromes, acute coronary syndromes and many others requires immediate intravenous drug infusions by either regular drop or micro drop infusion IV sets or with the help of infusion pumps. IV infusion dose calculation should be very precise for optimum treatment outcomes.[5-8] Resident doctors and nursing staffs managing such patients should be competent in calculations of IV drug doses.

Undergraduate medical students are taught IV infusion dose calculation in pharmacology subject practical curriculum. Doctors, nursing staff and medical students are using conventional methods for IV fluid drip drop rate for regular and micro drop calculation at present and these methods are tedious, time consuming and require complex mathematics.[9-11]

Table 3: Doctors (D1-D10) and nursing staff (N1-N10) volunteers survey data.

Participant	Mathematical complexity		Speed of using method		Comfort level of using the method		Accuracy of method		Applicability to ward		Recommend to use method		Overall grading		Average time require-ment (sec)	
Method	CM	IM	CM	IM	CM	IM	CM	IM	CM	IM	CM	IM	CM	IM	CM	IM
D1	3	8	2	8	3	8	10	8	3	8	3	8	4	8	13	3
D2	4	7	3	9	3	8	9	10	4	9	2	9	3	8	15	4
D3	4	7	3	8	3	8	10	9	4	8	3	8	4	7	12	2
D4	4	7	4	9	4	7	10	8	3	9	3	9	4	8	13	3
D5	3	8	2	8	3	7	9	10	4	9	2	8	4	9	14	3
D6	4	7	4	8	2	7	10	9	3	8	3	9	4	8	14	3
D8	3	8	3	8	3	8	10	9	3	8	3	8	3	8	15	4
D9	3	7	3	7	3	7	10	9	3	9	3	9	4	7	13	3
D10	4	7	3	8	3	8	10	10	4	8	3	8	4	8	14	2
N1	3	7	3	7	3	7	10	10	4	9	2	9	3	9	14	2
N2	3	8	3	8	3	8	10	9	3	9	2	8	3	8	13	3
N3	3	8	3	7	4	8	9	9	4	8	3	9	4	7	13	3
N4	4	7	2	8	3	8	10	10	4	9	3	8	3	8	14	3
N5	3	8	4	8	4	8	10	9	3	8	3	8	4	8	14	2
N6	3	7	3	9	3	8	10	10	3	9	3	8	3	8	14	3
N7	3	7	3	8	3	7	10	9	3	8	3	8	4	7	13	3
N8	3	7	3	8	3	8	10	9	4	9	2	9	4	8	14	3
N9	4	8	3	8	3	8	10	10	3	8	2	8	3	7	14	3
N10	3	8	3	8	4	7	10	10	3	9	2	8	4	8	14	3

Newly proposed innovative (NIM) IV drop calculation methods are as accurate as conventional method and are as quick as software base app methods. This new method takes average 3second and doesn't require any calculator help while conventional method require 14seconds and need calculator or software base app.

Developing countries do not have universal facility of infusion pump at every indoor bed and with doctors and nursing staffs using conventional method for drip drop rate calculation, this innovative method is a better and convenient alternate for the same. In developed countries, nurse patient ratio was 1:6, while in developing countries it is 1:40. Ideal nurse patient ratio for indoor treatment should be 1:4.[7] Because of overburden work of doctors and nurses in developing countries and for temporary hospital set ups during natural calamities and wars, these new innovative methods are boon. This new method of IV fluid calculation chart can be kept handy in ICU and wards for instant application. This new method can be useful for undergraduate pharmacology in IV drip drop rate calculation practical training.[4,9]

CONCLUSION

Invented IV fluid drip drop rate formula is easy, quick and superior in comparison to conventional method and it don't require any instrumental help. This invention is an ideal alternative of conventional formula for IV drip drop rate calculation in absence of infusion pump.

ACKNOWLEDGEMENTS

Authors would like to thank resident doctors and nurses of Zydus Medical College and Hospital, Dahod, India for participating in the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Moritz ML, Ayus JC. Maintenance intravenous fluids in acutely ill patients. New Eng J Med. 2015;373(14):1350-60.
2. Floss K, Borthwick M. Intravenous fluid therapy-background and principles. Pharmaceutical J. 2008:15:271-4.
3. Pattnaik KP, Mohapatra S, Mohanty M, Mohapatra BN, Patel D, Mukherji D. Clinical orientation of undergraduate pharmacology practicals: an intervention study. Ind J Pharmacol. 2006;38(3):200.
4. Tripathi KD. Essential of Medical Pharmacology. 7th ed. ND-India: Jaypee ; 2013.
5. Parmar DM, Jadav SP. Teaching undergraduate students appropriate dose calculations in relation to intravenous infusion. Ind J Pharmacol. 2006;38(6):435.

6. British National Formulary, London. Brit Med Assoc. 1995;11.
7. Undem BJ, Lichtenstein LM. Drugs used in the treatment of asthma. In: Hardman JG, Limbird LE, Gilman AG, eds. Goodman and Gilman's The Pharmacological Basis of Therapeutics. 10th ed. New York: McGraw-Hill; 2001.
8. Lack JA, Stuart-Taylor ME. Calculation of drug dosage and body surface area of children. Brit J Anaes. 1997;78(5):601-5.
9. Whalen K, Finkel R, Panavelil TA. Pharmacology. 6th ed. Philadelphia: Wolters Kluwer; 2015.
10. ONET Online. Summary Report for: 29-1141.00-Registered Nurses, 2018. Available at: http://www.onetonline.org/link/summary/29-1141.00.
11. Practice Problems. UNC School of Nursing Tutorial. Brief Explanation, 2014. Available at: https://reynoldsnursingsi.wordpress.com/category/.../dosage-calculation/. Accessed on 22 April 2014.

Cite this article as: Patel DM, Patel MV, Sharma KH, Kaklotar JC, Patel GR, Patel MM. Efficacy and superiority of an innovative method (IM) of intravenous (IV) fluid drip drop rate calculation using IV set and its comparison with conventional methods (CM). Int J Res Med Sci 2019;7:334-40.

Annexure

Sample Survey Form:

Date:

Title: Innovative IV Fluid drip drop rate formula study

Volunteer Name:

Designation:

Affiliation:

Details of IV fluid drip drop rate calculation by different methods is explained to me. I have understood it well and agree to do rating of both methods. All parameters are to be graded from interior to superior by giving 1 to 10 points (1 for most disliked and 10 for most liked).

Parameter	Conventional method	Invented method
Mathematical complexity		
Speed of using method		
Comfort level of using method		
Applicability to ward		
Recommendation of using method		
Accuracy of method		
Overall grading		
Time required in seconds		

Remark:

Signature: