Calculation of the Amount of Fluids Given During Neonatal & Pediatric Surgical Operations (New Formula: Ry Formula)

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ABSTRACT:

BACKGROUND:

A new formula (**RY** formula) for calculation of intra operative fluids given in neonatal & pediatric life threatening surgical operations was enrolled in this study.

OBJECTIVE:

To find a correct , simple ,easily applicable & understandable formula to avoid all unwanted dangerous mistakes in calculation of fluid requirements in all types of neonatal& pediatric surgical operations .

PATIENTS:

(*Five Thousands* Patients**)** including neonates , infants & pediatric age group presented to CWTH /Medical city /Baghdad for different types of surgical operations were enrolled in this study divided to 3 groups (Group A) Life threatening conditions 2300 patients , (Group B) Major& super major operations 700 patients &(Group C) Different types of elective surgical operations 2000 patients .

METHODS:

In this new (RY formula) intra operative fluid requirements calculated as :

Pre existing deficit (Fasting) : 20 ml/kg this amount is divided over 3 hours : ½ the amount given in the 1st hour of operation , and ¼ the amount is given for each the 2nd& 3rd hours of operations. Maintenance fluid requirements : 4 ml/kg/hr for all weights. 3rd Space replacement : 8 ml/kg/hr for major& super major operations & 4 ml/kg/hr for minor operations .

RESULTS :

By comparison of this new (RY formula) with most of other anesthesia text books fluid formulas and anesthetic references regarding this aspects the results is that the difference in the amounts of fluid requirements was minute and regarded as negligible difference .

CONCLUSION:

This new formula has been used for the last six years(2005-2010) in neonatal & pediatric anesthetic department in CWTH/ Baghdad Medical City complex for 5000 neonates ,infants & pediatric patients without any complications.This new formula is correct, simpler, safer ,easily applicable understandable than other formulas. The most important point in this new(RY formula) is that it can be summarized by just 2 numbers(22- 17)

22 ml/kg for the 1st hour & 17 ml for the 2nd&3rd hour of operation for major operations.

KEYWORDS: intraoperative fluid, life threatening surgical op,3rd space.

INTRODUCTION:

In Neonatal and Pediatric surgical and anesthetic department most of the patients in this age group present to the surgical theatre for general anesthesia for different types of life threatening and critical conditions in need for urgent surgical interference , these patients are of low weight (e.g. 2kg, 3kg…)

especially premature and neonates, with life threatening congenital anomalies (e.g imperforated anus, congenital intestinal obstruction ,Tracheo-esophageal Fistula (T.E.F),Congenital Diaphragmatic Hernia (CDH),….) also total blood volume in these patients is limited in amount (80-90 ml/kg)[1] so for these reasons a very precise and correct formula for calculation of fluid administered in these types of surgical operations should be applied ,because any mistake in calculation of the amount of the fluid needed in these operations may lead to dangerous outcome.

The classical formulas for calculation of fluid administrated during neonatal and pediatric surgical operations used by different pediatric anesthetic references and most Anesthetic Text Books[4,9,12] are as follows : *. Calculation of pre-existing deficit (Fasting amount (F).

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***.** Maintenance fluid requirement (Maintenance (M).

***.** Replacement fluid for 3rd space (3rd space amount).

Note : 3rd space loss refers to fluids which is lost from the circulation during surgery .Some of this fluid form edema in the area of operation some may be lost into the bowel and there may be losses from evaporation [10] . The more major the surgery the more replacement fluid will be required.

In all these classical formulas they calculate:

(1) . Fasting amount:

4ml /hour for 6 hour fasting per kg =

4ml x 6 hr x kg = **24 ml x kg**

Then they divide this amount over the 1st three **hours** of surgical operation as :

1/2 the amount given in the 1st hour of operation, 1/4 the amount given in the 2nd hour of operation. & 1/4 the amount given in the 3rd hour of operation. [4,12]

(2). Maintenance amount (**4-2-1** formula):

They give 4ml/kg for 1st 10 kg body weight , 2ml/kg for 2nd 10 kg & 1ml/kg for each kg above 20 kg . [4,10,12]

(3). 3rd Space loss :

A lot of formulas used here, some of these formulas calculate 3rd space loss as:

1 - 10 ml/kg /hr according to the type of pediatric operation.

Or **2-15ml /kg /hr** according to the type of pediatric operation. [12]

This represent much more difficult calculation than the maintenance amount ,because they give a wide range in amount of fluid calculated per kg (1-10 , 2-12 or 2-15 ml/kg) ,this may lead to dangerous calculation mistake[4,10,12] especially with less skill or less trained personal like junior anesthetic doctors and post- graduate students in pediatric anesthetic departments.

Note: some references use other formulas for calculating this 3rd space losses in pediatric age group such as:

e.g. : 2- 8 ml/kg/hr for minor & moderate types operation .

6 - 12 ml/kg/hr for major & super major operations.

This later formula is more acceptable, and for comparison with the new formula in this study a mean of this later formula will be chosen for 3rd space amount which is :

4ml /kg /hr for minor & moderate operations

8ml /kg /hr for major & super major operations.

PATIENTS AND METHODS:

PATIENTS :

Five thousands patients (a part from around 15 thousands patients) of neonatal , infant and pediatric age group presented to the pediatric surgical and anesthetic department in Children Welfare Teaching Hospital (CWTH)/ Medical City /Baghdad in a 6 years period (2005- 2010) for different types of life saving emergency operations or for elective surgery were selected to be enrolled in this study , these cases are as followed (Table 1) :

Group (A) : 2300 cases of life threatening and emergency operations these include : Tracheo-osophageal Fistula(TEF) 220 cases (mean age : 7 days), Congenital Diaphragmatic Hernia (CDH) 100 cases (mean age: 20 days) , Congenital Pyloric Stenosis 230 cases (mean age: 17 days) and Intestinal Obstruction (whether congenital or not) 1750 cases (age : premature ,neonates& infants) .

Group (B) : 700 patients presented with different types of major operations including (Biliary Atresia , Choledocal Cyst, Pull Through operation , Posterior Sagittal Ano Recto Plasty (PSARP), Sacrocoygeal Teratoma, Closure Colostomy , Willm's Tumors ….).

Group (C): 2000 patients presented for elective operations of different types like : (Spleenectomy , Inguinal and Umbilical Hernia , Hydrocel , Undecended Testis , Rectal surgeries , excisional biopsies from different types of tumors …..).

METHODS:

(I). In the new formula (**RY** formula) the intraoperative fluid is calculated as follows :

1. Pre existing deficit (Fasting amount):

is by giving

3ml /kg for 7 hours fasting so

= 21ml/kg

Fasting amount = 3ml x 7 hr x kg

This approximated to **20ml /kg** for easy calculation , this amount of fluid(similar to the classical formulas) also divided to 3 parts :

1/2 the amount given in the 1st hour of operation , 1/4 the amount given in each 2nd& 3rd hour of operation .

2 . Maintenance fluid requirement **:** here only one number is used which is **4ml / kg /hr ;** this number used for all pediatric age and weight. [9]

Note: this is an important gain, only one number used to avoid the difficulty in calculation of maintenance amount (4-2-1) in the classical formulas .

3. 3rd Space calculation: only 2 numbers
4ml /kg/hr for minor and moderate surgical operation.
8ml/kg/hr for major and super major surgical operation.
Summery; *this* ***new (RY) formula can be summarized by :***
Fasting (F) amount *is* ***20*** *ml/kg divided to(10ml, 5ml and 5ml)*
for the 1st , 2nd and 3rd hours of operation time respectively .
Maintenance (M) amount *is* ***4*** *ml/kg/hr.(for all ages&weights).*
3rd Space amount: ***4*** *ml/kg/hr minor & major operation*
8 *ml/kg/hr major & super major operation.*
e.g : for a baby with a major or super major operation , the total amount of fluid needed during his operation is calculated by this new (RY) formula is :
1st hr 10ml(F) + 4ml (M) + 8ml(3rd sp.) = 22ml/kg
2nd hr 5ml/kg + 4 ml/kg + 8 ml/kg = 17 ml / kg
3rd hr 5ml/kg + 4ml/kg + 8 ml/kg = 17 ml /kg
So (in summery) it is (22/ 17 formula) .
Note : *for* ***MINOR operation*** *we give* ***17 ml/kg*** *for the* ***1st hour…*** **-**
(II). In this study for easy comparison between the new (RY) formula and the classical (4 -2-1) formulas , the same numbers for calculation of **3rd space** amount has been used :
4ml/kg/hr for minor & moderate operation and **8**ml/kg/hr for major & super major operation.
(III). Different age group with different weights starting from 3kg, 5kg, 10kg, 15kg,…….,35kg for different types of surgical operations were enrolled in this study ,and the amount of intra-operative fluid calculated for the 1st , 2nd and 3rd hours of surgical operation time in both formulas (4-2-1 classical formulas and the new **RY** formula), then a comparison of the results in calculation is done (Table 2) **.**
- *Note* : Types of fluids used in this new (**RY**) Is the same that used in the classical formulas (Normal Saline , Glucose Saline & Ringer's solutions). [1,4]

Table 1: Types and numbers of surgical operations.

Types of surgical operations			Number of patients
Group A	. T E F* . CDH* . Pyloric stenosis .Intestinal obstruction (Congenital or not)	220 100 230 175O	2300
Group B	. Pull through operation. . PSARP*. . Renal & hepatic tumors (removal). . Scrocoxygeal teratomas (removal). . Biliary atresia. . Choledochal cysts.		700
Group C	. Spleenectomy. . Excional biopsy (abdominal tumors). . Inguinal& umblical hernia. . Hydrocele. . Undescended testicles. . Anoreectal surgeries.		2000

*TEF : tracheoesophageal fistula .
*CDH : congenital diaphragmatic hernia .
*PSARP : posterior sagittal anorectal plasty.

RESULTS:

From comparison table(Table 2) it is obvious that the difference in amount of fluid calculated for these 2 formulas is only **minute and regarded as negligible difference** (only : about 1ml/kg for the whole 1st hour of operation) especially when dealing with small weight babies .

Table 2 : Comparison between the classical (4-2-1) & the New (RY) formula(for the total intra operative fluid calculated in neonatal and pediatric patients).

- types of surgical operaion	weight	operation time	4-2-1 formula	RY formula	difference
major operation	3 kg	1st hour 2nd hour 3rd hour	72 ml 54 ml 54 ml	66 ml 51 ml 51 ml	-2ml/kg -1ml/kg -1ml/kg
major operation	5 kg	1st hour 2nd hour 3rd hour	120 ml 90 ml 90ml	110 ml 85 ml 85 ml	- 2ml/kg - 1ml/kg - 1ml/kg
major operation	10 kg	1st hour 2nd hour 3rd hour	240 ml 180 ml 180 ml	220 ml 170 ml 170 ml	-2ml/kg -1ml/kg -1ml/kg
major operation	15kg	1st hour 2nd hour 3rd hour	350 ml 260 ml 260 ml	330 ml 255 ml 255 ml	-1.3ml/kg -0.3ml/kg -0.3ml/kg
major operation	20 kg	1st hour 2nd hour 3rd hour	460 ml 340 ml 340 ml	440 ml 340 ml 340 ml	-1ml/kg nill nill
major operation	25 kg	1st hour 2nd hour 3rd hour	565 ml 415 ml 415 ml	550 ml 425 ml 425 ml	-0.6ml/kg +0.4ml/kg +0.4ml/kg
major operation	30 kg	1st hour 2nd hour 3rd hour	670 ml 490 ml 490 ml	660ml 510 ml 510 ml	-0.3ml/kg +0.6ml/kg +0.6ml/kg
major operation	35 kg	1st hour 2nd hour 3rd hour	775 ml 565 ml 565 ml	770 ml 595 ml 595 ml	-0.13ml/kg +0.8ml/kg +0.8ml/kg

DISCUSSION :

*. This simple new (RY) formula has been used for the last six years (2005- 2010) in the neonatal and pediatric anesthetic department in CWTH/Medical City / Baghdad for more than five thousands neonates , infants and pediatric patients for different types of surgical operations as shown in this study without any complications . * This new formula is a correct, safer, simpler, easily applicable and understandable formula by which we can avoid any unwanted dangerous mistake that may occur when using the classical (4-2-1) formula.[1]

*.The most important point in this new (RY) formula is that can be summarized by just 2 numbers :

* *(22 – 17) : give 22 ml/kg as total fluid calculation for major & super major operation in the 1st hour of surgery in pediatric patients and 17ml/kg as total fluid requirement for the 2nd &3rd hours of surgery.

Also give 17ml/kg as total fluid calculation in the 1st hour for minor operation.

CONCLUTION:

This new formula can be used effectively for calculation of intra operative fluid requirements for all neonates, infants and pediatric patients, and for all types of surgical operation in this age group , because; *. It is safe, correct, simpler, easily applicable and more understandable than the classical formulas *.It has been used for thousands of neonatal and pediatric surgical operations without any complications. *. It can be summarized by two numbers (22 – 17).

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