Hospital Topics

Problems of Administering Drugs by Continuous Infusion

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Summary

A study of how often drugs were administered by continuous intravenous infusion to patients occupying 110 surgical and 50 medical beds showed that an average of 48 drug additions were made to intravenous fluids each week: 15% of these were of more than one drug and 15% were of drugs incompatible either with each other or with the infusion fluid. As a result of the survey an educational programme was developed to bring these problems to the attention of the staff concerned. After this programme a second survey showed only 18 additives had been given to patients occupying the same 160 beds and none of these were incompatible mixtures.

Introduction

Over the last decade the practice of administering drugs by continuous intravenous infusion has become more common particularly in surgical units, where many patients receive intravenous fluids after their operations. This route of drug administration has many potential hazards and special precautions should be taken for therapy to be safe and effective. The main dangers are associated with incompatibility between the drug added and components of the infusion fluid,¹ possible decomposition over the time of administration,² and any bacterial or fungal contamination inadvertently introduced when the admixture is prepared.³ We report the frequency of use of this method of administration and the types of drug used in a sample of patients occupying medical and surgical beds in an acute general hospital, together with an assessment of the associated problems. An educational programme to minimize these problems is described and its effect is evaluated.

Methods

To determine the size and nature of the problem a standardized fluid-balance chart was specially designed to record the prescription and administration of all drugs given by intravenous infusion. A standardized system⁴ of recording drug prescription and administration had been introduced previously and the fluid-balance chart was developed using the same principles (fig. 1). An accurate record of all fluids given

by intravenous infusion and of the drugs added to these fluids was obtained for a representative sample of patients occupying 50 acute general medical beds and 110 surgical beds over four months (period 1). In view of the results of this survey an incompatibility chart (fig. 2) was developed and printed on the reverse of the fluid-balance chart so that the information would be available when the prescription was being written. The first section of the chart listed solutions to which it was not advisable to add any drugs; the second dealt with the problems of potassium chloride and penicillin administration, since these accounted for a large percentage of the drug additives; and the third listed important drugs and their known incompatibilities. Symposia on the problems of administering drugs by continuous intravenous infusion were organized for the main hospitals of the group and all medical, nursing, and paramedical staff were invited. This educational programme lasted six months and was followed by a second four-month survey of drugs added to intravenous solutions which covered the same beds as before (period 2).

Results

The first survey showed that surgical patients received by far the most drugs by intravenous infusion. During this period one or more drugs had been added to infusion fluids on 708 occasions; an average of nine drugs added per 25 beds per week (table I). Over the same period drugs were added to intravenous infusions on only 67 occasions for patients occupying the 50 medical beds; an average of two drugs added per 25 beds per week. For medical beds only one drug was added on each occasion whereas for the surgical beds 15% of the additives contained two or more drugs. In one case four drugs were added to one bottle of sodium chloride 0.9% w/v: 500 mg ampicillin, 500 mg cephaloridine, 100 mg hydrocortisone, and 1.5 g potassium chloride. Antibiotics were the most common additives apart from potassium chloride; ampicillin was added in 80% of these cases and cephaloridine and tetracycline in the remainder. Most of the incompatibili-

TABLE I—Survey of Intravenous Additives for Patients Occupying 50 Acute Medical Beds and 110 Acute Surgical Beds over Two Four-month Periods Separated by Six-month Education Programme

	Period One	Period Two
<i>50 acute medical beds</i>		
No. of additives	67	98
	(2/25 beds/week)	(3/25 beds/week)
% of bottles with two drugs added ..	Nil	3
% with antibiotic additives	22	3
<i>110 acute surgical beds</i>		
No. of additives	708	202
	(9/25 beds/week)	(3/25 beds/week)
% of bottles with two drugs added ..	14.5	1
% of bottles with three or more drugs added ..	0.8	Nil
% with antibiotic additives	60	6

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SPECIAL INSTRUCTIONS: *Aspirate 24hr. 25ml. water hourly.*

DUNDEE HOSPITALS
INTRAVENOUS
FLUID PRESCRIPTION
AND BALANCE SHEET

Date: 29-3-72

Bottle No.	FLUID	Commence	Finish	Signature	Given by	Time	Intake in Mls			Output in Mls			COMMENTS
							Bottle No.	I.V. Amt. Given	ORAL	Gastric	Stool/urine	Urine	
①	DEXTROSE 5% 500mg. CEPHALORIDINE	11am	3pm	f. Smith	A.B.	11am	① 500ml.	25 ml.	NIL				
						12pm		25 ml.				105	
						1pm		25 ml.				50	
②	SODIUM CHLORIDE 0.9% 500mg. CEPHALORIDINE 1.5 grams POTASSIUM CHLORIDE	3pm	7pm	f. Smith	A.B.	2pm		25 ml.			110		
						3pm	② 500ml.	25 ml.	15			175	BILE
						4pm		25 ml.				50	
③	SODIUM CHLORIDE 0.9% 500mg. CEPHALORIDINE	7pm	11pm	f. Smith	L.S.	5pm		25 ml.	10				BILE
						6pm		25 ml.			140	100	
						7pm	③ 500ml.	25 ml.	10			50	BILE
④	DEXTROSE 5% 500mg. CEPHALORIDINE			f. Smith	L.S.	8pm		25 ml.			160	50	
						9pm		25 ml.	15			110	BILE
						10pm							
⑤	SODIUM CHLORIDE 0.9% 500mg. CEPHALORIDINE	3am	7am	f. Smith	L.S.	11pm	④ 500ml.		15			250	BILE
						12am							
						1am							
⑥	SODIUM CHLORIDE 0.9% 500mg. CEPHALORIDINE	7am	11am	f. Smith	J.D.	2am	⑤ 500ml.						
						3am							
						4am							
						5am							
						6am		25 ml.				310	
						7am	⑥ 500ml.	25 ml.	NIL			250	
						8am		25 ml.					
						9am		25 ml.				130	
						10am		25 ml.				120	
Total							3000 ml.	400 ml.	65	410	1700		
Intake = 3,400 ml. Balance = +, 225 ml.							Output = 2175 ml.						
INSENSIBLE LOSS = 1000													
APPROXIMATE RATE OF FLOW FOR 500 MLS							KNOWN DRUG SENSITIVITY						
1 hr. = 120 Drops/Min 8 hr. = 20 Drops/Min							NAME						
4 hr. = 30 Drops/Min 6 hr. = 15 Drops/Min							BROWN JANE						
							WARD						
							50						
							HOSPITAL						
							A. G. H.						

FIG. 1—Standardized intravenous fluid prescription and balance sheet.

ties discovered (table II) were combinations of ampicillin with hydrocortisone or cephaloridine, both of which change the pH of the solution from that at which ampicillin is stable.

TABLE II—Survey of Intravenous Additives for Patients Occupying 110 Acute Surgical Beds over a Period of 14 Months

Periods of Two Months	No. of Bottles of Intravenous fluid with Drugs Added	% of Multiple Additives	No. of Bottles with antibiotics Added	% of Additives which were of Published Incompatibilities
1	386	13	262	7
2	322	19.1	164	15
3	174	24.5	107	24
4	165	10.9	132	3
5	130	6.2	39	9.2
6	131	2.3	12	2.3
7	71	Nil	Nil	Nil

After the educational programme the number of drug additives for surgical patients was reduced to a quarter of the original figure and the percentage of multiple additives fell from 15% to 1%. There was also a tenfold decrease in the number of times antibiotics were administered by continuous intravenous infusion.

Finally, a detailed analysis was made of the pattern of drug administration by continuous infusion to patients occupying the surgical beds over the whole fourteen-month period. The results are expressed in two-monthly periods (table II). Periods one and two cover the time of the first survey, periods three, four, and five the six-month educational programme, and periods six and seven the second survey.

The 50% decrease in the number of infusion fluids with additives between study periods six and seven was contributed to by the introduction, at the end of period six, of commercial infusion fluids of sodium chloride 0.9% and dextrose 5% with 3% potassium chloride already added. The results show a fourfold drop in the number of occasions drugs were administered by intravenous infusion, a striking feature of which was the marked decrease in the use of this route of drug administration for antibiotics. The practice of adding several drugs to one bottle of infusion fluid also decreased. Furthermore recognized drug incompatibilities were eliminated.

INCOMPATIBILITIES OF DRUGS
added to
INTRAVENOUS INFUSIONS

DO NOT add DRUGS to the following solutions

AMINO ACID SOLUTIONS
LIPID MIXTURES
MANNITOL SOLUTIONS — check solution has not crystallised
BLOOD and BLOOD PRODUCTS

POTASSIUM CHLORIDE
Normally not more than 80 MEQ. K⁺ (6 grams POTASSIUM CHLORIDE) should be infused in 24 hours

PENICILLINS
Add ONLY to SODIUM CHLORIDE 0.9% solution and prepare IMMEDIATELY before ADMINISTRATION

AMPICILLIN	NO other drugs to be added to infusion
CEPHALORIDINE	TETRACYCLINES, ERYTHROMYCIN incompatible
CHLORAMPHENICOL	TETRACYCLINES, HYDROCORTISONE incompatible
ERYTHROMYCIN LACTOBIONATE	Add ONLY to DEXTROSE 5% NOT ELECTROLYTE Solutions. NO other drugs to be added to infusion.
HEPARIN	Add PREFERABLY to SODIUM CHLORIDE 0.9% solution. ANTIBIOTICS, HYDROCORTISONE incompatible
HYDROCORTISONE SODIUM SUCCINATE	ANTIBIOTICS, HEPARIN incompatible
IRON DEXTRAN	See MANUFACTURER'S LITERATURE
TETRACYCLINES	NO other drugs to be added to infusion. Do NOT add to solutions containing Calcium.
COMPOUND VITAMINS INJECTION	INADVISABLE to add a MULTIPLE CONSTITUENT injection to an infusion

CONSULT the PHARMACY DEPARTMENT about OTHER DRUGS to be added to an Infusion solution
REMEMBER to affix a "DRUG ADDITIVE" label to each infusion bottle with an ADDITIVE.

FIG. 2—Incompatibility chart.

Discussion

The increased use of intravenous fluids, particularly in surgical wards, has provided a readily available route for drug administration. The extent to which this route was being used was first realized after the introduction of a standardized chart for the prescription of all fluids and drugs administered by continuous intravenous infusion. Accurate records enabled information to be readily abstracted and analysed. Results of the survey carried out during period one show that the hazards of this route of drug administration, particularly those of incompatibilities between drugs and infusion fluids and the difficulty of obtaining therapeutic blood levels of antibiotics in this way,⁵ were not widely appreciated. Measurements were made of ampicillin blood levels in patients receiving 500 mg ampicillin diluted in 500 ml of 0.9% w/v sodium chloride solution over four hours to show that this route of drug administration was ineffective in obtaining therapeutic blood levels of antibiotics. An educational programme was begun to alert nursing and medical staff to the problems associated with giving drugs by continuous intravenous infusion. The first part introduced the incompatibility chart (fig. 2) which provides a continuous form of education as the information is always available at the time the prescription is written. The second part consisted of symposia covering not only incompatibilities and contamination occurring when drugs are administered by continuous intravenous infusion but also the difficulty of obtaining a therapeutic blood level of the drug when it is run in at an erratic

rate from a dilute solution. Results of the second survey clearly show the success of this programme.

The problems associated with intravenous additives have been studied before, notably at the London Hospital,⁶ where an incompatibility chart has been designed, but this development has not occurred in conjunction with a standardized fluid-balance chart. The multidisciplinary team of medical, nursing, and pharmaceutical staff working in Dundee enabled all aspects of the problem to be studied at once and a comprehensive policy developed.

It is a great pleasure to acknowledge the help of Professor James Crooks and the medical and nursing staff of the wards covered by the surveys. This work was supported by the S.H.H.D., D.H.S.S. and W.H.O.

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Any Questions?

We publish below a selection of questions and answers of general interest

Accuracy of Serum Cholesterol Estimations

Does the accuracy of estimations of serum cholesterol levels vary with the method used? If so, are the variations significant?

There are slight variations in the accuracy of results obtained for serum cholesterol determinations when performed by different methods. These differences are exemplified by the mean results obtained from inter-laboratory comparisons. One example of such a comparison, in which 195 laboratories reported the results for the analysis of samples obtained from one pool of serum, is shown in the following table:

Results (in mg/100ml) of Cholesterol Analysis using Different Methods (Serum distributed 25 September 1971)¹

	Auto Analyzer*	Manual Liebermann Burchard	Manual Zak
No. of results	43	93	49
Mean	202.51	202.47	198.10
S.D.	11.68	17.29	18.40
C.V.	5.76	8.54	9.29

*Technicon Instruments Company, Basingstoke, Hants

As shown in the table, the mean values for the different sets of determinations differ very little, and certainly no medical significance can be attached to such minor variations in the mean. However, the table indicates that cholesterol measurements lack precision, and in fact the individual results reported in the above survey range from 150 to 280 mg/100ml. Variations in results for serum cholesterol determinations can reach significant proportions, owing to lack of analytical precision, even when specimens are being ana-

lysed in just one laboratory. This lack of analytical precision can reach medical significance, and its effect can be accentuated by failure to ensure the collection of specimens from patients under standard conditions.

- ¹ Whitehead, T. P., Browning, D. M., and Gregory, A., *Journal of Clinical Pathology*, 1973, 26, 435.

Notes and Comments

Cystitis and Urethritis after Intercourse.—Dr. J. A. BURGESS (Wakefield, Yorks) writes: With reference to your expert's reply to this question ("Any Questions?" 22 December, p. 732) recurrences of sexually-induced urinary tract infection can be prevented in many women without recourse to drugs. The regimen given here, which includes some of your expert's advice, has proved successful: (1) Both partners should be free from genito-urinary disease. A patient who has had an episode of cystitis or urethritis should not have sexual intercourse until investigations have shown that the urinary tract is free from infection; (2) at the time of intercourse the woman's bladder should be fairly full of urine. Because of this requirement many couples will find that the most satisfactory time for coitus is in the morning shortly before their usual time of rising; (3) every woman who has a deficiency of genital secretions should apply some plain water-soluble lubricant to the vaginal orifice before intercourse; (4) though pre-coital love-play may be prolonged coitus should be of relatively brief duration; (5) within two or three minutes after her partner has ejaculated the woman should rise and urinate, emptying her bladder as completely as possible.