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Drug Utilization in a General Intensive Care Unit

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Abstract. Drug utilization in 200 general ICU patients was retrospectively studied. One hundred and two different drugs were prescribed with a mean of 7.0 ± 4.6 drugs/patient. The potential for polypharmacy and drug interactions is discussed, as is the cost of such therapy.

Key words: ICU, Drug Costs, Polypharmacy.

Intensive Care Units (ICU) represent areas for specific and concentrated therapy of many types, including drug therapy. Our clinical experience in an 18 bedded general ICU which handles 1200 - 1400 patients per annum, is that polypharmacy may well be a problem of importance. To our knowledge with the exception of the recent report by Aranda et al [1], no data exists on drug utilization in an ICU environment. This apparent lack of information was the motivating factor for the present study.

Methods

Two hundred consecutive case records were retrospectively analysed to ascertain basic data concerning the patients such as their age, duration of ICU stay, mortality etc. Pharmacological data were obtained by analysing all the drugs prescribed with the exception of topical preparations and intravenous fluids. The following information was sought:

(a) The total number of different drugs used.
(b) The incidence of drug usage.
(c) The route of administration.
(d) The total dose of each drug prescribed for all 200 patients to assess the cost of drug therapy.

From the point of view of costing, it has to be borne in mind that for certain drugs the total content of a vial may not have been used, the remainder being discarded. In such instances the cost of the entire vial was taken as the true expenditure.

Results

The patients were referred from cardiac surgery (30.5%), general medicine (25.5%), general surgery (16%), paediatrics (13%) and other disciplines (15%). The ages of the patients (Table 1) were such that the majority were aged between 15 and 60 years. The mean duration of stay in ICU for all 200 patients was 3.43 ± 3.6 days (range 1 -29 days), and was similar to that for those who demised, 2,82 ± 3.9 days (range 1 - 17 days). Mortality was 24.5 %.

One hundred and two different drugs were prescribed for the 200 patients and the mean number of drugs prescribed per patient was 7.0 ± 4.6 (range 1 - 26). Seventy-six percent of the drugs were administered intravenously, 15,4 orally, 7.1% intramuscularly, 1.2% per rectum and 0.3% subcutaneously. No correlation was observed between either the number of drugs prescribed per patient in those who survived ($r = 0.00067$) or in those who demised ($r = 0.16$).

As might be expected in a population group where infective, cardiac and renal disease are common, certain specific drugs were used much more commonly than others (Table 2). Penicillin and gentamicin were the most common antibiotics employed. The high incidence of sodium cephalothin (keflin) usage reflects the preference by the cardiac surgical team for this drug as a postoperative antibiotic. The high incidence of furosemide usage (55%) reflects a combination of the fact that many post cardiac surgery and general medical patients required diuretics. Digoxin was employed almost exclusively in post cardiac

Table 1. The ages of the 200 patients studied

	% of Patients
< 1 month	9.0
1 month - 1 year	6.0
13 months - 5 years	7.5
6 years - 14 years	15.5
15 years - 60 years	54.0
> 60 years	8.0

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surgery patients. Morphine and valium were used predominantly for sedation in ventilator and post-surgery patients, as was indomethacin for hyperpyrexia and mild analgesia. Pancuronium bromide was employed (29,5% cases) to control ventilator patients including patients with tetanus, as was sodium bicarbonate (29.5% cases) for the treatment of metabolic acidoses.

To provide an impression of the volume of drugs employed in the management of these 200 patients, data is provided in Table 3. The cost of all the medication provided was in the region of 15700 rands (10500 pounds)[1] (18000 US dollars)[1] which represents an individual cost of 78,5 rands (52.3 pounds, 90.0 US dollars), or a daily expense of 23 rands/patient (15,3 pounds, 26.4 US dollars).

Discussion

The present study was regarded as a preliminary one to assess pharmacological practices in a large general ICU staffed in part by rotating registrars who do a great deal of the prescribing. Naturally the disease processes treated in an ICU will reflect those prevalent in the population. In the present instance the bulk of patients were suffering from disorders seen predominantly in developing societies, namely infective cardiac and renal disease; hence therapy must show a bias towards these disorders. Nevertheless it is probable that the principles of the present study apply to intensive care units in general.

Firstly, the majority of drugs (76%) were administered intravenously, in most cases by nursing sisters. The importance of this observation is that nurses should be "au fait" with the principles and hazards of this route of drug administration [2]. In our experience, nurses are always

[1]Calculated according to current exchange rates which should be regarded as approximate

Table 3. The amount of the 10 most commonly used drugs in the management of the 200 patients described. The number of patients receiving a particular drug and the mean amount received per patient for the duration of their ICU stay is also shown

Drug	Number of Patients	Total amount of drug	Amount of drug per patient
Furosemide	110	23,120 mg	210.2 mg
Penicillin	110	3695 million units	33.6 million units
Gentamicin	87	29,529 mg	339.4 mg
Indomethacin	70	132 suppositories	1.9 suppositories
Morphine	69	816 mg	11.8 mg
Digoxin	62	37.3 mg	0.60 mg
Sodium cephalothin	61	479 g	7.9 g
Diazepam	60	5,757 mg	95.9 mg
Sodium bicarbonate	59	7,068 mEq	119.8 mEq
Pancuronium	50	1,451 mg	29.0 mg

Table 2. The percentage of the 200 patients studied receiving a specific drug. The actual percentage for each drug is shown in brackets. Drugs received by 1 % or less of patients are given in the appendix

30 % Patients		29.9-10.0% Patients		9.9-5.0 % Patients		4.9-1.1% Patients	
Furosemide	(55.0)	Sodium bicarbonate	(29.5)	Potassium chloride i.v.	(9.5)	Ethambutol	(4.5)
Penicillin	(55.0)	Pancuronium	(25.0)	Dopamine	(9.5)	Hydroxyzine	(4.0)
Gentamicin	(43.5)	Cloxacillin	(21.5)	Aluminium hydroxide	(9.0)	Propanolol	(4.0)
Indomethacin	(35.0)	Oral Potassium chloride	(18.0)	Lincomycin	(8.5)	Heparin	(4.0)
Morphine	(34.5)	Calcium chloride	(14.0)	Aminophylline	(8.5)	Chloromycetin	(3.5)
Digoxin	(31.0)	Isoprenaline	(12.0)	Dexamethazone	(7.5)	Chlorpromazine	(3.5)
Sodium Cephalothin	(30.5)	Streptomycin	(12.0)	Vitamin K	(7.5)	Ascorbic acid	(3.5)
Diazepam	(30.0)	Ampicillin	(11.5)	Omnopon	(6.0)	Lignocaine	(3.0)
		Hydrocortisone	(10.0)	Warfarin	(5.5)	Paracetamol	(3.0)
				Hexoprenaline	(5.0)	Tetanus toxid	(3.0)
				Isoniazid	(5.0)	Dihydralazine	(3.0)
						Kaolin Pectin	(3.0)
						Prednisone	(2.5)
						Neomycin	(2.5)
						Atropine	(2.5)
						Anti-Tetanus serum	(2.0)
						Spironolactone	(2.0)
						Vitamin B Co	(2.0)
						Co-trimoxazole	(2.0)
						Pethidine	(2.0)
						Phenobarbitone	(2.0)
						Metaclopramide	(2.0)
						Mepyramine maleate	(1.5)
						Insulin	(1.5)
						Rifampicin	(1.5)
						50 % Dextrose	(1.5)
						Adrenaline	(1.5)
						Vitamin A & B	(1.5)
						Vitamin C i.v.	(1.5)

taught the hazards of intramuscular injections, but rarely those of the intravenous route. This is a particular importance in an ICU environment where most patients have central venous lines in situ which are frequently used for drug administration. The dangers of bolus administration of drugs such as digoxin, sodium bicarbonate etc. via such lines should be stressed.

Iatrogenic disease has become a fashionable expression and is indeed a regrettably common event. In our ICU experience it has been possible to identify certain specific iatrogenic problems such as digitalis toxicity, renal dysfunction associated with furosemide and gentamicin, hypokalaemia associated with high dose corticosteroids and dopamine induced gangrene [3]; however probably many more such instances pass unobserved. For this reason, it was of interest to note that there was no significant difference in the number of drugs prescribed for those patients who survived and those who demised. The number of drugs prescribed per patient for the whole group showed a mean value of 7.0 ± 4.6 drugs; however the range was such that one myasthenic patient admitted for observation received but one drug, whilst another patient with subacute bacterial endocarditis, renal failure, hepatic failure and seizures received 26 drugs. The potential for drug interactions in such situations must be almost infinite, and should be as carefully considered as possible. Of greatest concern in the context of our own practice is the use of 4 drugs, digoxin, furosemide, diazepam and gentamicin. Digoxin is frequently used in conjunction with furosemide and although hypakalaemia is actively looked for, it may occasionaly pass unnoticed. Digitalis toxicity has been uncommon in our experience, but a thorough study in this regard is required. Furosemide is extensively used and has often resulted in profound hypokalaemia; this may be of particular importance in low albumin states [4]. Diazepam also produces more unwanted effects in hypoalbuminaemic patients, and this phenomenon needs close observation [4]. A further cause of concern is the potential occurrence of ototoxicity and nephrotoxicity associated with the concomitant usage of furosemide and gentamicin.

From the point of view of expense, approximately 15700 rands (18000 US dollars) (10500 pounds) was expended upon 200 patients. On the basis of cost per patient/day this did not seem excessive, however on an annual basis in the context of 1200 - 1400 patients this represents an expenditure of about 100000 rands (114000 US dollars, 67000 pounds). Moreover bearing in mind that this hospital serves a population of 1 million persons, handling 65000 in-patients and 1270000 out-patients attendences per annum with an overall pharmacy expenditure on drugs of approximately 1850000 rands (2122000 US dollars, 1233000 pounds), ICU drug expenditure is very considerable representing 4.5% of all hospital pharmaceutical costs. For this reason, let alone for reasons of ethical medical practice, it is imperative that those working in an ICU environment should actively scrutinize and restrict their pharmacological activities. This may prove difficult to do by virtue of the emergency situations under which drug administration often occurs, but this in itself should stress the need for careful consideration before giving a drug to critically ill patients.

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Appendix

Drugs given to 1% or less of patients:

Thiamine, sulfadiazine, mannitol, multivitamins, ferrous sulphate, folic acid, aprotinin (Trasylol), methylprednisone (Solumedrol), doxapram hydrocholoride, amoxycillin, carbenicillin, diphenoxylate hydrochloride and atropine (Lomotil), probanthine, prochlorperazine (Stemetil), suxamethonium, cephaloridine, erythromycin, tobramycin, clindamycin, kanamycin, metronidazole, piperaine, ethionamide, trichloryl, phenytoin and phenobarbitone (Garoin), neomercazole, potassium iodide, Lugol's iodine, pitressin, reserpine, isoptin, metaraminol bitartrate, procaineamide, oxprenolol (Trasicor), nicotinic acid, pyridoxine, potassium chloride (Slow K), Vitamin B_{12}^{1}, antitetanus serum, mycostatin, syntocinon and THAM.

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