was noncompliant\textsuperscript{13} and the therapy of one patient was not described.\textsuperscript{10}

Although it is hard to draw many conclusions on such a limited number of patients, the two patients who survived longer than six months\textsuperscript{14,15} and the currently described patient have similarities in treatment that separate them from the non-long-term survivors. All three long-term survivors received and had good response to prolonged treatment with two antibiotics to which the \textit{R} \textit{equi} isolate was proven to be sensitive. The patient described by Weingarten et al\textsuperscript{12} was treated with erythromycin, clindamycin and tetracycline, which resulted in improvement for six months. The patient described by Sirera et al\textsuperscript{13} was treated with intravenously administered ciprofloxacin and chloramphenicol for three weeks and was discharged on a regimen of the same oral drugs for suppression. These cases and the current case suggest that \textit{R} \textit{equi} pneumonia should be treated intravenously for three to six weeks with at least two antibiotics to which the \textit{R} \textit{equi} isolate has proven sensitivity. Also, since this organism is a central nervous system pathogen,\textsuperscript{8} the choice of antibiotics with good central nervous system penetration should be considered. Intravenous therapy should then be followed by two oral antibiotics for an indefinite period of time and perhaps for life.

REFERENCES


Clearance of Theophylline by Hemodialysis in One Patient with Chronic Renal Failure\textsuperscript{*}

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The clearance of theophylline by hemodialysis was determined in one patient who had polycystic kidney with chronic renal failure and bronchial asthma. The serum levels of theophylline were determined by enzymatic immunoassay on two consecutive days, once on a dialysis day and again on a nondialysis day. Clearance of theophylline by hemodialysis was 119 ml/min, and the extraction efficiency was 0.56. The elimination half-life of theophylline shortened from 5.7 h to 1.6 h during hemodialysis. The dialysis rate constant (Kd) was 0.32/h, and 79 percent of the total body store of the drug was removed during a 4-h dialysis. Patients receiving theophylline who are maintained on hemodialysis should be closely monitored for bronchospasm during and after the hemodialysis procedure. Measurement of serum concentrations of theophylline should be employed to facilitate increases in dosage during hemodialysis.

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Hemodialysis has been regularly utilized therapeutically as a supportive treatment for end-stage renal disease; however, the effects of renal failure and hemodialysis on elimination of theophylline are not clear, and dosage guidelines for administering theophylline during hemodialysis are not well defined.\textsuperscript{1} In nonsmoking subjects with normal hepatic and cardiac function, total body clearance of theophylline is highly variable, ranging from 30 to 120 ml/kg/h.\textsuperscript{2,3} Only 7 to 13 percent of the parent compound is excreted unchanged in the urine,\textsuperscript{4,5} and renal theophylline clearance ranges from 3 to 9 ml/min/m\textsuperscript{2} in persons with normal renal function.\textsuperscript{5,6} It is assumed that total body clearance and dosing requirements should be relatively unchanged in renal failure.\textsuperscript{1}

Since theophylline (molecular weight, 180) is only partially protein-bound (53 to 65 percent) and since the volume of distribution is small (0.3 to 0.7 L/kg), a significant fraction of the drug should be cleared by hemodialysis.\textsuperscript{5,7} Moreover, hemodialysis was suggested to be a treatment for patients with theophylline intoxication.\textsuperscript{8} Therefore, to clarify the effect of hemodialysis on elimination of theophylline, we administered aminophylline to one patient who had polycystic kidney with chronic renal failure and bronchial asthma.

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The Vd for theophylline was 22.2 L on the nondialysis day and was treated as a constant during hemodialysis. According to equation 5, (Kd = CLd/Vd), this information leads to the interpretation that hemodialysis will clear 32 percent (Kd = 0.32/h) of the body store of theophylline per hour. After a continuous 4-h hemodialysis, 79 percent of the body store of theophylline will be cleared.

Total body clearance (164 ml/min) during hemodialysis equals total body clearance of the nondialysis day (45 ml/min) plus dialysis clearance (119 ml/min). According to equation 6, the half-life of theophylline during hemodialysis was reduced to 1.6 h.

Discussion

Numerous factors affect the removal (or dialysis) of a drug in hemodialysis, including (a) the physicochemical properties of the drug, eg, molecular weight and water solubility; (b) the mechanical properties of the dialysis system, eg, surface area, porosity, and thickness of the dialyzer membrane; (c) monitoring factors, eg, blood flow and dialysate flow; (d) pharmacokinetic factors, eg, volume of distribution, inherent metabolic clearance, and protein binding.

The effect of hemodialysis on theophylline clearance has been studied by several investigators, and the average hemodialysis clearance ranged from 32.8 to 99 ml/min. In this study, hemodialysis clearance of theophylline was 119 ml/min. The variability observed in dialysis clearance could be related to different blood flow rates (300 ml/min in this study, as compared with 100 to 200 ml/min in previous studies), dialysate flow rates, and the different dialyzer used.

In agreement with previous reports, hemodialysis significantly shortened the elimination half-life of theophylline from 5.7 to 1.6 h. Comparing with 28 to 53 percent removal in the report of Kradjan et al., 79 percent of the drug in the body was removed during a 4-h dialysis in this study. For the patient in this study, 79 percent of the loading dose of theophylline should be added at the onset of dialysis to maintain the serum theophylline level, and aminophylline (Phyllocontin, 450 mg bid) was continued on the nondialysis as well as dialysis days.

Nevertheless, hemodialysis clearance of theophylline varies substantially and may be dependent on the dialysis system, especially the different blood flow rates and different dialyzers used. Patients on hemodialysis who are receiving theophylline should be carefully monitored for exacerbations of bronchospasm during and after the hemodialysis procedure. In addition, serum levels should be obtained to facilitate possible dosage increases that may be required.

References

15 Slaughter RL, Green L, Kohli R. Hemodialysis clearance of theophylline. Ther Drug Monit 1982; 4:191-93
16 Blouin RA, Bauer LA, Bustrack JA. Theophylline hemodialysis clearance. Ther Drug Monit 1986; 2:221-23

Imaging of Multiple Coronary Artery Fistulas to Right Ventricle by Transthoracic and Transesophageal Echocardiography*

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A 20-year-old woman presented with extremely rare multiple coronary artery fistulas with left circumflex and right coronary arteries as the feeding vessels and two distinct sites of drainage into the posterior wall of the right ventricle near the apex in close proximity. The larger left fistula was well depicted by transthoracic echocardiography, whereas the transesophageal approach better delineated part of the smaller right fistula.

(Chest 1992; 102:1623-25)

Experience with different patterns of coronary artery fistula (CAF) examined by both the transthoracic and transesophageal two-dimensional echocardiography (TTE)

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