Outbreak, investigation, and results

The outbreak comprised three definite (cases 1, 2, and 4), one probable (case 3), and one possible (case 5) case of nosocomial legionella pneumonia (table). All patients were receiving steroids or insulin and we estimated the risk of infection for such patients. Patients in hospital from 1 to 14 September 1983, which was considered to be the high risk period, and receiving immunosuppressive or antidiabetic drugs were identified from medical records and hospital pharmacy prescriptions to patients at discharge. Serum samples from these patients taken between 24 November and 2 December were tested by the rapid microagglutination test¹ and (if titres were ≥ 8) an indirect fluorescent antibody test. Water samples were collected from the cooling tower and the domestic circuit.

No common exposure within the hospital was identified. All patients were in different wards. Only one patient (case 1) showered in the hospital before the onset of symptoms. In addition to the patients in cases 1-5, 101 (6%) out of 1818 patients in the hospital during 1 to 14 September 1983 were in the high risk groups. One of 39 (n=64) patients having immunosuppressive drugs and one of 18 (n=37) diabetic patients were seropositive (cases 6 and 7). One of these (case 6) had had lower respiratory tract symptoms five days postoperatively.

The estimated attack rate for high risk patients between and 1 and 14 September 1983 was 3% (3/106), or 5% (3/61) if non-responders are excluded. The infection rate was between 5% (5/106) and 8% (5/61), or between 6/1000 (3/485) and 10/1000 (5/485) person days exposed.

One shower water sample from near the room of the patient in case 2 yielded *L pneumophila* serogroup 1, which was indistinguishable by monoclonal antibody typing² from the two human isolates but differed from the strains isolated from water in the same hospital in 1980 (J Tobin, personal communication).

Comment

The recommendations for control of water temperature do not have unanimous support because of doubts about the effectiveness, cost benefits, and potential hazards such as scalding.³ This outbreak is circumstantial evidence that the recommended control measures had reduced the risk of infection. Possibly the reduction in hot water temperatures over eight weeks allowed organisms already colonising the water system to multiply to levels infectious for immunocompromised patients. Evidence that the domestic water supply was the source of infection came from the monoclonal typing.

Subsequent investigations showed that legionellas had not been eradicated from the hospital water system, and in practice eradication may not be necessary or possible. Whereas hyperchlorination and temperature regulation have successfully controlled outbreaks of legionnaires' disease elsewhere, legionellas have still been isolated from water samples.⁴

Others have shown that *L pneumophila* is very frequently present in plumbing systems of large buildings which are not associated with human cases of legionellosis.⁵ Hence the mere isolation of legionellas from hospital water systems does not prove a causal relation with coincidental nosocomial cases, nor that, in the absence of such cases, there is a serious risk of infection. We emphasise, however, that where legionellas are present in hospital water systems prospective active surveillance of nosocomial respiratory infections is essential.

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Out of depth, out of breath

We describe three patients who were unable to breathe when they stood in water and had difficulty in swimming.

Case reports

Case 1—A 46 year old man first noticed that he could not breathe in water when he dived into the Thames for a swim. Initially he thought that this was because of the coldness of the water but subsequently found that, although he was able to breathe comfortably as he walked into shallow water, he became increasingly dyspnoeic when the level rose above his abdomen. He had also noticed mild dyspnoea when jogging and playing tennis. On examination he was breathless when supine and had paradoxical inward motion of the abdomen on inspiration. Radiological screening showed paradoxical motion of the diaphragm in the supine position. Testing of the respiratory muscles showed weakness of the diaphragm; oesophageal and gastric pressures were measured with balloon catheters attached to differential pressure transducers,¹ and transdiaphragmatic pressure was obtained by an electronic subtraction of gastric pressure minus oesophageal pressure. Transdiaphragmatic pressure was 20 cm H₂O (normal >80 cm H₂O)² during a maximal sniff, 10 cm H₂O (normal >25 cm H₂O)³ during a maximal inspiration to total lung capacity, and 15 cm H₂O (normal >18 cm H₂O)⁴ during a maximal static inspiratory manoeuvre from residual volume. No systemic cause for diaphragm weakness was identified.

Case 2—A 26 year old man known to have muscular dystrophy had for 18 months been unable to swim because of shortness of breath. He could paddle in shallow water, but when the level rose above his pelvis he became progressively dyspnoeic. Investigations showed diaphragm weakness. Transdiaphragmatic pressure was 7.5 cm H₂O during a maximal sniff, 2.5 cm H₂O during a maximal inspiration, and 7.5 cm H₂O during a maximal static inspiratory effort.

Case 3—A 54 year old woman had been unable to breathe when she stood in deep water. For 12 months she had been having nightmares of choking at night

Clinical and serological data

Case No	Sex and age	Underlying disease	Admission dates	Onset of legionnaires' disease	Sera	Micro-agglutination titre	Indirect immuno-fluorescence titre	Isolation
1	F 40	Graves' disease treated with dexamethasone and cyclosporin A	1/9/83-	16/9/83	{ 2/9/83 20/9/83 22/9/83	<4 128 512	16 256 256	Sputum
2	F 75	Insulin dependent diabetes	31/8/83-7/9/83	8/9/83	{ 15/9/83 23/9/83 27/9/83 30/9/83	<4 64 32 64	<16 64 64 64	
3	M 64	Systemic lupus erythematosus treated with prednisone	26/8/83-2/9/83	12/9/83	{ 29/9/83 10/10/83 17/11/83	4096 >4096 >512	4096 4096 >512	Lungs (necropsy)
4	M 64	Rheumatoid arthritis treated with prednisone; fractured femur fixed on 30/9/83	28/8/83-	5/10/83 (died 9/10/83)	{ 30/9/83 8/10/83	8 64	16 128	
5	M 77	Eczema treated with whole body topical betamethasone. Proctocolectomy 21/9/83	2/8/83-	26/9/83	{ 5/10/83 10/10/83 17/10/83	64 32 8	16 32 16	
6	M 59	Ulcerative colitis treated with prednisone	29/8/83-5/10/83	?26/3/83	24/10/83	512	1024	
7	M 54	Diabetes, leg amputation	15/8/83-12/9/83		4/11/83	128	256	

and was breathless when she stooped. Since having been buried for several hours after bombing during the war she had suffered from claustrophobia, and her symptoms were thought to be due to anxiety. On examination she had no abdominal paradox, but investigations showed pronounced diaphragm weakness. Transdiaphragmatic pressure was 38 cm H₂O during a maximal sniff, 17.5 cm H₂O during a maximal inspiration, and 6 cm H₂O during a maximal static inspiratory effort. This patient had autoimmune disease with a history of Hashimoto's thyroiditis, systemic sclerosis, and Raynaud's disease.

Comment

Patients with complete paralysis of the diaphragm are known to complain of dyspnoea and gross orthopnoea. Examination of the patient in the supine position shows paradoxical inward inspiratory motion of the anterior abdominal wall.³ By contrast, patients who have mild weakness of the diaphragm may complain of shortness of breath only during exertion and often do not have orthopnoea or paradoxical abdominal motion.⁵ As a result, diaphragm weakness may not be suspected clinically, and the symptoms may be considered to be psychogenic unless transdiaphragmatic pressures are measured.

Patients with moderate diaphragm weakness can usually breathe comfortably when standing. During expiration they contract the abdominal muscles, thereby pushing the abdominal contents up into the chest and raising the diaphragm. During inspiration descent of the weak diaphragm is assisted by the downward action of gravity on the abdominal contents. When patients are immersed in water above the abdomen, however, the additional weight of water prevents adequate abdominal expansion and thus descent of the diaphragm, resulting in dyspnoea. Diaphragm weakness should be considered in any patient who complains of inability to breathe when standing in deep water.

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New portable infusion pump for prolonged subcutaneous administration of opioid analgesics in patients with advanced cancer

Pain associated with advanced cancer is well controlled with oral medication in most patients. For those unable to take drugs by mouth continuous subcutaneous infusion of opioid analgesics using a portable syringe driver has become an established technique.^{1,2} In Britain the Graseby Dynamics MS series syringe drivers are the most widely used and are usually reprimed every 24 hours.³ We have investigated a new portable infusion device which can be set to run for up to 37 days without repriming.

Materials, methods, and results

Act-a-Pump (Pharmacia) is a peristaltic pump housed in a rigid container measuring 9.5×3.8×10.5 cm and weighing 425 g (figure). It has a 75 ml disposable reservoir and can deliver drug solutions at flow rates of 2-110 ml/24 h. The flow rate is set by a separate flow rate meter. The device is powered by a rechargeable battery pack and, as with the Graseby syringe drivers, can be worn in a shoulder holster pouch or on a belt. Its main use at present is for continuous infusions of cytotoxic chemotherapy.

Diamorphine is preferred to morphine for parenteral administration in patients with cancer because it is much more soluble. A concentration of 250 mg

diamorphine/ml (25% wt/vol) is a convenient maximum for continuous infusions.⁴ Few patients will need more than 2 ml (500 mg) a day.

Stability of diamorphine—Freeze dried diamorphine hydrochloride for injection is usually prepared immediately before use and discarded after 12 or 24 hours in the interests of sterility. This practice is widely misperceived to have been based on the limited chemical stability of diamorphine in aqueous solution. We investigated the stability of diamorphine in the device over two weeks while it was being worn by a healthy volunteer. The concentrations of monoacetylmorphine and morphine, the main breakdown products of diamorphine, together represented less than 1% of the final concentration of diamorphine (as measured by high performance liquid chromatography⁵). The solution of diamorphine was made up under sterile conditions in the pharmacy, and laboratory examination over the two weeks showed no bacterial contamination.

Clinical use—We have accumulated a total of 407 days' use of the pump in four patients. Two patients found it so convenient that we decided not to take it from them to try in others. Both were outpatients: one used it continuously for seven and a half months and had it reprimed by a district nurse once a fortnight using a ready filled reservoir made up in the local hospital pharmacy; the other used the pump for four months. We have had one pump failure (after six months continuous use) and one incident of leakage from poorly connected tubing.

New portable infusion pump.

Comment

In hospital practice repriming syringe drivers presents no difficulty, but for patients at home a daily visit from the district or specialist nurse would usually be necessary. Patients receiving continuous opioid infusions are usually ill and in need of close supervision, so that a daily visit may in any case be required. For these patients, the majority, syringe drivers will be preferred. Some patients, however, will not need frequent visits, and for them the present device has definite advantages. Our two outpatients much preferred it to the syringe driver.

The Act-a-Pump infusion system remains completely closed between reprimings. This has meant fewer changes of the infusion site for our outpatients, presumably because of a lesser tendency to cause subclinical infection or inflammation. Disadvantages of the pump are its bulk and weight and the complexity of setting it up compared with syringe drivers.

Administration of opioids, which are not as soluble as diamorphine, will be easier with Act-a-Pump because of its large reservoir. This may enable the technique of continuous subcutaneous infusion to be used more widely outside Britain than at present.

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