after discontinuation of digoxin while receiving diltiazem 300 mg daily. In another study, two people with previous episodes of heart failure deteriorated when digoxin was discontinued.

Results were similar when monotherapy with verapamil was compared with digoxin. Verapamil improved heart rate during exercise compared with digoxin in three studies. Exercise tolerance with verapamil alone improved in two of the three studies that tested it. The combination of digoxin with verapamil provided better heart rate control at rest and during exercise than digoxin alone. However, bradycardic episodes or pauses were sometimes seen with the combination. Exercise tolerance was not consistently improved despite better heart rate control, with some studies reporting improvement and others no change. Concomitant use of both drugs increases digoxin concentrations.

Limitations to the use of verapamil and diltiazem include their negative inotropic effects and considerable dose related side effects.

In patients with chronic atrial fibrillation, digoxin has been the mainstay of treatment for many years, so new recommendations relegate digoxin should be evidence based and safe. We believe that little evidence exists that monotherapy with β blockers or calcium channel blockers improves exercise tolerance compared with digoxin. On the contrary, there is clear evidence that when β blockers are used alone, exercise capacity may worsen, especially in people with a history of heart failure.

Similarly, little evidence exists that monotherapy with these drugs improves heart rate control at rest and during exercise compared with digoxin alone. Beneficial effects on heart rate variability, together with improved exercise tolerance, have only been shown with the combination of digoxin and a β blocker or calcium channel blocker. We believe that the combination of digoxin and a β blocker or calcium antagonist should be recommended as first line management. We emphasise that it is safest to start treatment with digoxin first.

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Meningitis after cochlear implantation

The risk is low, and preventive measures can reduce this further

Since the 1980s, more than 80000 people have received cochlear implants worldwide. These implants are designed to enable people who are severely or profoundly deaf to experience sound and speech. Since 1990, implantation has become standard treatment for people who cannot communicate effectively despite well fitted hearing aids. Children who are deaf when they are born can perceive sound and learn to speak if they receive cochlear implants at a young age (ideally under 18 months). The use of cochlear implants has been thought to be safe. But since 2002 the number of patients with meningitis related to cochlear implantation has increased worldwide. Mortality and neurological complications after meningitis are high. We need to investigate the reasons for this and look at measures to reduce them.

Streptococcus pneumoniae is the most common organism involved. The incidence of pneumococcal meningitis was found to be more than that of an age matched cohort in the general population. Risk factors include: a particular design of implant (withdrawn from the market in 2002); inner ear malformations; leakage of cerebral spinal fluid after implantation; presence of a ventricular-peritoneal shunt; and a history of otitis media.

An animal model of implant related pneumococcal meningitis has been developed. This model has been used to quantify the bacterial threshold for pneumococcal meningitis and to study the pathogenesis of the disease and interventional strategies for reducing risk. A laboratory study showed that the presence of a cochlear implant in healthy animals reduced the number of bacteria needed to induce pneumococcal meningitis and therefore increased the risk of meningitis. Moreover, the surgical insertion of the implant, which involves fracturing the bony structures of the inner ear, was also an independent factor for subsequent risk of pneumococcal meningitis.

Patients and their carers need to be informed of the risk of developing meningitis after implantation. This is especially true for patients with pre-existing risk factors. Patients should be told that although a cochlear implant increases the relative risk of pneumococcal meningitis compared with the age matched population, the absolute risk of meningitis is still low and the benefits of the implant outweigh this low risk.

What can be done to reduce the risk of meningitis? The risk of developing meningitis after cochlear implantation can be lowered by implementing several strategies. All implant recipients should be given vaccines that cover Streptococcus pneumoniae as recommended by the US Centers for Disease Control and Prevention. Patients who develop symptoms of acute otitis media or bacteraemia should be assessed and treated urgently. This is particularly important for recipients of cochlear implants who have other pre-existing risk factors. Oral antibiotics may be adequate for most episodes of uncomplicated acute otitis media in implant recipients. Intravenous antibiotics should be combined with mastoid drainage to prevent meningitis in recipients with mastoiditis. We recommend the insertion of tymanostomy tubes and the use of prophylactic antibiotics in implanted children prone to otitis media until they grow out of their susceptibility to otitis media.

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