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Original Article

Prophylactic antibiotics in interventional paediatric cardiac catheterisation: old habits die hard?

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Abstract Antibiotic prophylaxis in congenital cardiac disease has long been a topic of debate. Although there is little dispute around antibiotic cover for surgical procedures and catheter interventions where foreign material is being inserted, there are little data specific to non-device-placement procedures such as atrial septostomy or balloon valvotomy. We sought to assess the effect of routine prophylaxis on post-interventional infections via a retrospective pseudo-randomised analysis, and an online survey on paediatric interventional cardiologists in the United Kingdom and United States.

Keywords: Bacterial endocarditis; prophylactic antibiotics; interventional cardiology; catheterisation

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Introduction

Antibiotic prophylaxis for cardiac surgery and other surgical interventions in children with CHD has been the subject of debate since at least 1955.[1] The latest guidelines from the American Heart Association and the National Institute for Health and Clinical Excellence have both suggested major changes to practice from those previously issued,[2,3] with antibiotic prophylaxis now being reserved for only the highest-risk cases. The reduced call for routine prophylactic antibiotics reflects the extremely low number of cases of infective endocarditis that might be prevented by this previously widespread practice.[4]

Cardiac catheterisation has evolved over the last 40 years as a routine tool in both diagnosis and management of congenital cardiac disease in childhood. It is considered a safe procedure with rates of major complications ranging from 1.5 to 3.7% and mortality reported as 0.13–1.5%, with lower figures representing more recent studies.[5] The main classes of complication are vascular injuries, arrhythmias, thrombosis, and device-specific problems. Infections, particularly infective endocarditis, although a concern for many years in CHD, are rare enough to be grouped under "miscellaneous" in long-term studies into catheter-related outcomes.[6,7]

The need for antibiotics during catheter procedure is ill defined. In the current context of encouraging an evidenced-based approach to antibiotic prescription, we considered whether a case could be made for a more judicious and thoughtful approach. Catheter procedures can be broadly divided into three main categories: diagnostic, interventional, and therapeutic electrophysiological studies.[8] We would suggest that interventional procedures and electrophysiological studies should both be further subdivided and considered as those that involve implantation of foreign material versus those procedures that do not. Although current evidence is clear that device-placement procedures should receive antibiotic prophylaxis at the time of insertion, particularly for pacemaker insertion,[9–11] there is little or no evidence pertaining to the non-device-placement group. Within the United Kingdom, there is variability in practice both between and within departments. Given that the rates of infection following

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cardiac catheterisation are low, we believe there is an opportunity for reducing antibiotic exposure, and all associated risks, in the non-device-placement group. In this way they could be treated in line with diagnostic catheterisation studies.[12]

In our institution, there is no unifying protocol on the administration of antibiotics for interventional cardiac catheterisation; instead, individual operators act as per their experience, training institution, and personal literature review. For device-placement procedures, all operators routinely give a single dose of Flucloxacillin and Gentamicin – unless the patient has a known allergy to penicillin-based antibiotics when an alternative such as Teicoplanin is administered – before device implantation. For non-device-placement procedures, three operators do not administer antibiotics routinely, whereas two operators administer antibiotics as described above. None of our operators administer antibiotics for diagnostic studies unless there is an indication specific to that child. With all other parameters being equal in our catheter laboratory environment, we believe this allows a novel retrospective pseudo-randomised controlled assessment of the benefit of routine prophylaxis in non-device-placement procedures.

Methods

We initially used Surveymonkey™ to survey paediatric interventional cardiologists in the United Kingdom and canvassed opinion from our colleagues in Canada and the United States to gauge international variation in practice. We retrospectively identified all children (<17 years) who underwent interventional cardiac catheter procedures, including electrophysiological studies, over a 2-year period – 1 December, 2010 to 30 November, 2012 – from the hospital database (Heartsuite™) and cross-referenced these with the surgical logbooks. We excluded those children in whom foreign material was implanted during the index catheter procedure and those children undergoing emergency procedures outside of the catheter laboratory. In eligible subjects, data were collected from Heartsuite™ with particular reference to procedure undergone, principle operator, and administration of antibiotics. The notes were then reviewed for evidence of deviation from normal operator practice via examination of anaesthetic records, the operation note, and prescription charts. Evidence of infective episodes were sought via departmental morbidity meeting minutes for complication reports, via clinic letters and inspection of the Heartsuite™ database, and the hospital notes looking for evidence of acute infection or subsequent admissions with bacterial endocarditis.

This was a retrospective study and did not require ethical approval as it was part of our ongoing overall service evaluation. At the time of the index procedure, consent for the use of anonymised data for research purposes is taken as routine. Simple descriptive statistics for data analysis were used.

Results

The online Surveymonkey™ questionnaire was completed by 24 of the registered paediatric interventional cardiologists in the United Kingdom (n = 34), all of whom were invited by e-mail to participate. Of these, 15 (62.5%) replied that they did not administer routine antibiotic prophylaxis in non-device-placement cases; however, all 24 respondents advocated the use of antibiotics in cases involving implantation of foreign material. We then expanded the initial survey to incorporate the experiences of our trans-Atlantic colleagues. We contacted 36 major cardiology centres in the United States and Canada via the Paediatric Interventional Early Careers group and had replies from 21 physicians. None of these had administered prophylactic antibiotics in non-device-placement procedures. One unit administered antibiotics if there was manipulation of a previously implanted stent or device. There were no cases of systemic bacterial endocarditis associated with non-device-placement procedures reported from this survey. There were two incidences of endocarditis following manipulation of pre-existing indwelling central venous catheters reported from the Paediatric Interventional Early Careers group. This has been well described in the literature.[13,14]

At our centre, we performed 436 interventional procedures on 381 different children during the study period. Of them, 212 procedures involved device placement and nine took place outside of the catheter laboratory under emergency conditions, with a potentially less than sterile field. There were no reported deviations from normal operator behaviour during the study period. Therefore, in total, 215 eligible procedures were undertaken over the 2-year period. These cases were made up of 133 interventional catheters and 82 electrophysiological interventions. Of these 215 procedures, 78 (36.3%) included the use of routine prophylactic antibiotics, whereas 137 did not. There were no recorded episodes of local wound infection, septicaemia, or subsequent infective endocarditis across the entire cohort during the study period. There were five deaths within 30 days of a catheter procedure in our study population, three of which were eligible procedures. These deaths were not attributed to complications of the index catheter procedure but as a consequence of the underlying CHD and other comorbidities.

Discussion

Infective endocarditis in children has a current incidence quoted at 0.36–0.64 cases per 100,000 per year in all children.[15] CHD markedly increases the risk, and these children account for over 40% of all infective endocarditis admissions and 80% of deaths in a recent large cohort study.[14] Treatment of infective endocarditis involves a prolonged course of antibiotics and up to a third require some form of cardiac intervention, including debridement of vegetations and valve repair/replacement surgery.[14,16] Given the potentially grave outcomes of an episode of infective endocarditis, we must be vigilant against the risk of an iatrogenic episode, and numerous guidelines have addressed the need to prophylaxis as discussed previously.

Our study considers the subset of interventions where no foreign material is placed, such as atrial septostomy and balloon valvotomy procedures. We have demonstrated that, despite not using antibiotics in 64% of patients in this subset, there were no cases of infective endocarditis, bacterial septicaemia, or local wound infection. This suggests that there is no benefit gained when administering antibiotics to children with CHD for a non-device-placement cardiac catheter intervention. We accept that ours is a relatively small cohort compared with some other studies; however, ours has the unique advantage of pseudo-randomisation owing to consistent and distinct operator practice.

We believe a study powered to show a significant difference in rates of infective endocarditis, bacterial septicaemia, or local wound infection following cardiac catheterisation would require numbers achievable only through cohesive international collaboration. Mehta et al[7] studied over 11,000 consecutive cardiac catheter interventions and identified only two systemic infections and seven febrile episodes, without mention of confirmed endocarditis. As we have been unable to locate any data for the incidence of infective endocarditis following non-device-placement interventions, it is impossible to carry out an accurate power calculation. Estimates suggest that greater than 10,000 in each arm of a trial would still not be adequately powered.

In a preliminary attempt to collate national UK outcome data, we have consulted the National Institute for Cardiovascular Outcomes Research, Central Cardiac Audit Database. UK-wide figures during the financial years from 2010 to 2012 show there were 1448 non-device-placement procedures performed on children. Data are unfortunately not available on whether these children received prophylactic antibiotics preceding these interventions; however, our preliminary survey suggests that up to two-thirds of these may not have.

As an adequately powered study is likely to be impractical, and given the implication from our data that non-device-placement interventions do not increase the risk significantly, we suggest a number of additional points for consideration when making a decision on prophylaxis.

Risk of allergic reaction

Patient reported incidence of penicillin allergy ranges from 1 to 10%,[17,18] with true life-threatening penicillin allergy having an incidence of 0.01–0.05%.[19] Cardiac catheterisation is often not the first sensitising exposure to penicillin in our population, given the propensity for early prescription of antibiotics in the community for patients with CHD. Alternate broad-spectrum antibiotic choices for those patients who have the "penicillin-allergic" label are usually more expensive, with a greater side effect profile, may be less effective than penicillin, and encourage emergence of multi-drug-resistant organisms.[20] It has been suggested that the risk of death from penicillin-related drug reactions is significantly higher than the risk of death from infective endocarditis, although those making these suggestions were describing dental procedures not cardiac catheterisation.[21]

Drug errors

The danger of Gentamicin in the paediatric population has been extensively studied and the risks of ototoxicity and nephrotoxicity are well documented.[22] A single dose of Gentamicin in itself should not be detrimental to health, but errors do occur. Ghaleb et al[23] describe how 13.2% of drug prescriptions have errors, with incorrect dose being the third commonest form. In addition, 19.1% of medications administered are given incorrectly, with dose, rate, and timing all being common mistakes.

Streamlining processes

Reducing complexity by minimising steps and streamlining processes reduces errors and has a significant improvement in patient outcomes. One model for this is the Toyota Production System, a manufacturing concept with the goal of maximising profits by minimising waste through limiting the number of steps in a procedure.[24] Culig et al[25] are one of the groups who have applied this concept in health care, reducing their cardiac operative mortality to 61% below average and complication rate to 57% below the regional rate using such a system. Removing the need for antibiotics could be an important step in streamlining the catheter laboratory and improving global outcomes.

Efficacy

The effectiveness of prophylactic antibiotics in preventing infective episodes has not been proven. In a

recent review on 60 years of infective endocarditic episodes, it was noted that five patients had received prophylaxis before an intervention – dental in this case – and then gone on to develop infective endocarditis within 2 weeks.[26]

Conclusion

The number of procedures included here are relatively large for a single-centre study in paediatric cardiology. Despite this, and owing to the rarity of post-procedure endocarditis, the number required to power a study to give a definitive answer in this scenario is prohibitive without long-term, cohesive, and international collaboration. We have consequentially exercised caution in our conclusion. We believe that there is little evidence to support the routine administration of prophylactic antibiotics ahead of non-device-placement interventions for childhood CHD in the low-risk patient. Avoiding this potentially unnecessary therapy would negate the possibility of anaphylaxis or side effects from antibiotics, remove the chance for drug prescription or administration errors, and increase efficiency in the catheter laboratory as a whole. Further prospective multicentre collaboration, potentially through national reporting systems, could be used to ascertain the final answer to this question in the future.

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Conflicts of Interest

None.

Ethical Standards

Data were collected in accordance with institutional ethical committee guidelines.

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