Performance of re-used pacemakers and implantable cardioverter defibrillators compared with new devices at Groote Schuur Hospital in Cape Town, South Africa

Zimasa V Jama, Ashley Chin, Motasim Badri, Bongani M Mayosi

Abstract

**Objectives:** Little is known about the performance of re-used pacemakers and implantable cardioverter defibrillators (ICDs) in Africa. We sought to compare the risk of infection and the rate of malfunction of re-used pacemakers and ICDs with new devices implanted at Groote Schuur Hospital in Cape Town, South Africa.

**Methods:** This was a retrospective case comparison study of the performance of re-used pacemakers and ICDs in comparison with new devices implanted at Groote Schuur Hospital over a 10-year period. The outcomes were incidence of device infection, device malfunction, early battery depletion, and device removal due to infection, malfunction, or early battery depletion.

**Results:** Data for 126 devices implanted in 126 patients between 2003 and 2013 were analysed, of which 102 (81%) were pacemakers (51 re-used and 51 new) and 24 (19%) were ICDs (12 re-used and 12 new). There was no device infection, malfunction, early battery depletion or device removal in either the re-used or new pacemaker groups over the median follow up of 15.1 months [interquartile range (IQR), 1.3–36.24 months] for the re-used pacemakers, and 55.8 months (IQR, 20.3–77.8 months) for the new pacemakers. In the ICD group, no device infection occurred over a median follow up of 35.9 months (IQR, 17.0–70.9 months) for the re-used ICDs and 45.7 months (IQR, 37.6–53.7 months) for the new ICDs. One device delivered inappropriate shocks, which resolved without intervention and with no harm to the patient. This re-used ICD subsequently needed generator replacement 14 months later. In both the pacemaker and ICD groups, there were no procedure-non-related infections documented for the respective follow-up periods.

**Conclusion:** No significant differences were found in performance between re-used and new pacemakers and ICDs with regard to infection rates, device malfunction, battery life and device removal for complications. Pacemaker and ICD re-use is feasible and safe and is a viable option for patients with bradyarrhythmias and tachyarrhythmias.

Keywords: re-used devices, pacemakers, ICDs, performance, safety

**The Cardiac Clinic, Department of Medicine, Groote Schuur Hospital, Cape Town, South Africa**
Zimasa V Jama, MB ChB, zvjam@gmail.com
Ashley Chin, FCP (SA), MPhil
Bongani M Mayosi, FCP (SA), DPhil

**College of Medicine, King Saudi Bin, Abdulaziz University for Medical Sciences, Riyadh, Kingdom of Saudi Arabia**
Motasim Badri, PhD

Submitted 17/2/15, accepted 12/4/15
Cardiovasc J Afr 2015; 26: 181–187 www.cvja.co.za
DOI: 10.5830/CVJA-2015-048

Pacemaker implantation is an effective tool to treat bradyarrhythmias, and implantable cardioverter defibrillators (ICD) reduce mortality in patients at high risk of sudden death. The challenge with pacemakers and ICDs is the high cost of these devices. The pacemaker generator, in its most basic form, costs US$2 500–3 000 and leads cost US$800–1 000. An ICD generator costs US$20 000–40 000 and leads cost over US$10 000. The high cost of pacemakers and ICDs has resulted in limited access of deserving patients in poor countries to these life-saving interventions.

Mond et al. demonstrated an increase in pacemaker and ICD implantation rates in all countries that participated in the World Survey of Cardiac Pacing in 2009. Despite this increase in implantation rates, there was a huge difference in the number of implants between the developed and underprivileged countries, with more implants in the developed world. This disparity was explained mainly by the high cost of these devices.

Re-use of cardiac pacemakers has been practiced since the early 1970s. The major concern with this practice is the risk of device infection and malfunction. Device infection is the most feared complication of cardiac device re-use and is thought to be associated with case fatality rates between 2.6 and 18%. However, some studies from America, Europe and Asia that examined the performance of re-used pacemakers and ICDs have shown no significant difference in infection or mortality rates between patients who received re-used and new devices.

The aim of this study was to investigate the performance of re-used pacemakers and ICDs at Groote Schuur Hospital, Cape Town, South Africa.

**Methods**

This was a retrospective case comparison study of performance of re-used versus new pacemakers and ICDs at Groote Schuur Hospital, Cape Town, South Africa. We included consecutive devices that were implanted between 1 January 2003 and 1 January 2013. As shown in Fig. 1, there were 1 721 devices implanted during that time, of which 1 587 (92.2%) were pacemakers and 134 (7.8%) were ICDs. Of the 1 587 pacemakers, 1 257 (79.2%) were new implants and 330 (20.8%) were generator replacements. Of the 134 ICDs, 114 (85.1%) were new implants and 20 (14.9%) were generator replacements.

There were 54 (3.4%) re-used pacemakers and 12 (9%) re-used ICDs implanted during this period, with a total number of 66
(3.8%) re-used devices implanted, as shown in Fig. 1. Patients with re-used devices (cases) were then matched by age, gender and date of implantation on a 1:1 basis to patients with new devices (controls). In the pacemaker group, cases and controls were matched to the same month of implantation, and for the ICD group, to the same year of implantation.

Devices for re-use were obtained from cadaveric donors. They were inspected for external damage and tested for remaining battery life. Devices with less than two years of battery life remaining and/ or with external evidence of damage were not re-used. Only devices with two or more years of battery life remaining with no evidence of external damage were eligible for re-use.

The eligible devices were sterilised by immersion in biozyme for 24 hours, followed by peroxide for a further 24 hours and then orthozyme for another 24 hours. After the three days of chemical treatment, the devices were dried out using pressurised air and subsequently subjected to gas sterilisation. In the gas sterilisation unit, they were put in a machine with ethylene oxide at three- to four-monthly intervals. Patients with ICDs were followed up more frequently and/or battery depletion. The definitions of the outcomes are as follows.

The outcomes of interest were procedure-related infection, device malfunction, early battery depletion, and device explantation for infection, malfunction and/or battery depletion. The definitions of the outcomes are as follows.

- Procedure-related infection: infections were classified into four types:23 (1) right-sided endocarditis with lead involvement; (2) sepsis with evidence of involvement of the lead and implantation pocket; (3) involvement of the pacemaker implantation pocket; and (4) involvement of the lead or generator. Infections were considered early if the onset of illness was within the first month of implantation, and late if the onset of illness was after the first month to a year after implantation. Infections that occurred after a year of implantation were considered not to be related to the procedure.23
- Device malfunction was defined as inability to sense or pace when required.
- Early battery depletion was defined as battery depletion within six years of implantation for new devices. For re-used devices, early battery depletion was defined as battery depletion within one to two years of implantation for those with two to four years of battery life remaining, and within two

## Outcomes

The outcomes of interest were procedure-related infection, device malfunction, early battery depletion, and device explantation for infection, malfunction and/or battery depletion. The definitions of the outcomes are as follows.

- Procedure-related infection: infections were classified into four types:23 (1) right-sided endocarditis with lead involvement; (2) sepsis with evidence of involvement of the lead and implantation pocket; (3) involvement of the pacemaker implantation pocket; and (4) involvement of the lead or generator. Infections were considered early if the onset of illness was within the first month of implantation, and late if the onset of illness was after the first month to a year after implantation. Infections that occurred after a year of implantation were considered not to be related to the procedure.23
- Device malfunction was defined as failure of the device to accomplish the desired role, e.g. in the case of an ICD, not able to sense ventricular tachycardia/fibrillation and deliver appropriate treatment. In the case of a pacemaker, device malfunction was defined as inability to sense or pace when required.
- Early battery depletion was defined as battery depletion within six years of implantation for new devices. For re-used devices, early battery depletion was defined as battery depletion within one to two years of implantation for those with two to four years of battery life remaining, and within two

### Table 1. Devices implanted 2003–2013

| Category                 | New (%) | Re-used (%) |
|--------------------------|---------|-------------|
| Pacemakers              | 1,587 (92.2) | 330 (20.8) |
| ICDs                     | 134 (78) | 20 (14.9)   |
| First implants           | 1,257 (79.2) | 114 (85.1) |
| Generator change         | 330 (20.8) | 20 (14.9)   |
| Re-used devices          | 54 (3.4)  | 66 (3.8)    |
| Excluded, n (%) = 3 (4.5) Missing data |

ICDs = implantable cardioverter defibrillators

**Fig 1. Outline to assess eligibility for enrolment.**
years of implantation for those with four years or more of battery life remaining at the time of implantation, provided this depletion was not explained by high pacing outputs or abnormal electrode impedance.

- Device explantation for infection, malfunction and/or battery depletion involved removal of the pacemaker or ICD due to infection, malfunction or early battery depletion.

Data extraction

The cardiac clinic electrophysiology database was used to identify the cases with re-used devices and the controls with new devices. Data were extracted from clinical notes in the cardiac clinic and additional information from pacemaker cards in the cardiac catheterisation laboratory and clinical records. Patient status was taken from clinical notes, the hospital electronic record (Clinicom) and the records of the Department of Home Affairs.

Statistical analysis

Categorical data were summarised as proportions and continuous data as means and standard deviations or medians and interquartile range. Categorical data were compared using the chi-squared test, and continuous data using the Student’s t-test or Mann–Whitney test. All tests were two-sided and a p-value of < 0.05 was considered significant. IBM SPSS (version 19, IBM Corp, NY, USA) was used to perform the analysis.

Results

Three patients with re-used pacemakers were excluded from the analysis because of missing records. Data for 126 devices inserted in 126 patients between 2003 and 2013 were analysed, of which 102 (81%) were pacemakers (51 re-used and 51 new) and 24 (19%) were ICDs (12 re-used and 12 new). For the pacemaker group, the median follow up for patients with re-used devices (cases) was 15.1 months [interquartile range (IQR), 1.3–36.24 months] and for those with new devices (controls) it was 55.8 months (IQR, 20.3–77.8 months). In the ICD group, the median follow up for patients with re-used devices (cases) was 15.1 months [interquartile range (IQR), 1.3–36.24 months] for the cases and 55.8 months (IQR, 1.3–70.9 months) for the controls.

For the pacemaker cases, 10 (19.6%) patients were followed up for five years or more, 18 (35.3%) for one to five years, and 23 (45.1%) for less than a year. For the pacemaker controls, 23 (45.1%) patients were followed up for five years or more, 21 (40.8%) for one to five years, and 10 (19.6%) for less than a year.

Table 1. Characteristics of patients who received pacemakers

| Characteristics                  | Patients with re-used pacemakers (cases) | Patients with new pacemakers (controls) | p-value |
|----------------------------------|------------------------------------------|-----------------------------------------|---------|
| Sample size, n                   | 51                                       | 51                                      |         |
| Age, years                       | 74.33 ± 12.26                            | 72.86 ± 16.13                           | 0.658   |
| Gender, n (%)                    |                                           |                                         |         |
| Male                             | 24 (47.1)                                | 24 (47.1)                               | 1.00    |
| Female                           | 27 (52.9)                                | 27 (52.9)                               |         |
| Co-morbidities, n (%)            |                                          |                                         |         |
| Hypertension                     | 26 (51)                                  | 35 (68.6)                               | 0.069   |
| Diabetes mellitus                | 7 (13.7)                                 | 13 (25.5)                               | 0.135   |
| Renal impairment                 | 17 (33.3)                                | 19 (37.3)                               | 0.679   |
| Cancer                           | 7 (13.7)                                 | 3 (5.9)                                 | 0.49    |
| Myocardial infarction            | 6 (11.8)                                 | 11 (21.6)                               | 0.29    |
| Cardiomyopathy                   | 4 (7.8)                                  | 6 (11.8)                                | 0.74    |
| CVA                              | 12 (23.5)                                | 3 (5.9)                                 | 0.02    |
| COPD                             | 5 (9.8)                                  | 1 (2)                                   | 0.21    |
| Dementia                         | 10 (19.6)                                | 6 (12)                                  | 0.008   |
| NYHA functional class 1          | 3 (5.9)                                  | 7 (13.7)                                | 0.32    |
| NYHA functional class 2          | 15 (29.5)                                | 27 (52.9)                               | 0.026   |
| NYHA functional class 3          | 14 (27.5)                                | 14 (27.5)                               | 1.00    |
| Wheelchair bound                 | 4 (7.8)                                  | 3 (5.9)                                 | 1.00    |
| Bed bound                        | 15 (29.4)                                | 0 (0)                                   | <0.0001 |
| Indications                      |                                          |                                         |         |
| Sinus rhythm syndrome, n (%)     | 9 (17.6)                                 | 4 (7.8)                                 | 0.138   |
| No                               | 42 (82.4)                                | 47 (92.2)                               |         |
| AV block, n (%)                  | 38 (74.5)                                | 43 (84.3)                               | 0.22    |
| No                               | 13 (25.5)                                | 8 (15.7)                                |         |
| Other, n (%)                     | 4 (7.8)                                  | 4 (7.8)                                 |         |
| No                               | 47 (92.2)                                | 47 (92.2)                               |         |
| First implantation, n (%)        | 43 (84.3)                                | 45 (88.2)                               | 0.565   |
| Battery change, n (%)            | 8 (15.7)                                 | 6 (11.8)                                | 0.565   |
| Primary implant                  |                                          |                                         |         |
| Cardiologist                     | 25                                       | 25                                      | 1.00    |
| Cardiology registrar             | 26                                       | 26                                      | 1.00    |
| Temporal lead, n (%)             | 17 (33.3)                                | 21 (41.2)                               | 0.413   |
| Follow up at 3 months, n (%)     | 26 (51)                                  | 43 (84.3)                               | 0.317   |
| No                               | 25 (49)                                  | 8 (15.7)                                |         |
| Follow up at 1 year, n (%)       | 19 (37.3)                                | 38 (74.5)                               | <0.0001 |
| No                               | 32 (62.7)                                | 13 (25.5)                               |         |

CVA = cerebrovascular accident; COPD = chronic obstructive pulmonary disease; NYHA = New York Heart Association; AV block = atrioventricular block; n = number; (%) = percentage; Other = atrial fibrillation and heart failure.
Table 2. Pacemaker parameters

| Parameters                  | Patients with re-used pacemakers (cases) | Patients with new pacemakers (controls) | p-value |
|-----------------------------|------------------------------------------|----------------------------------------|---------|
| DDD, n (%)                  | 11 (21.6)                                | 7 (13.7)                               | 0.30    |
| VVI, n (%)                  | 39 (76.5)                                | 42 (82.4)                              | 0.463   |
| Other, n (%)                | 1 (2)                                    | 2 (3.9%)                               |         |
| Minimum pacing rate, bpm    | 63.4 ± 6.0                               | 61.6 ± 5.1                             | 0.09    |
| Ventricular pacing, n (%)   | 50 (98)                                  | 49 (96.1)                              | 0.558   |
| Battery voltage, V          | 2.78 (2.77–2.79)                         |                                        |         |
| Battery current, A          | 13.86 ± 4.9                              |                                        |         |
| Battery impedance, Ω        | 0.482 ± 0.3                              |                                        |         |
| Estimated battery life (years) | 6.085 ± 1.7                         |                                        |         |
| Capture                     |                                         |                                        |         |
| Amplitude, V                |                                         |                                        |         |
| Atrial                      | 0.48 ± 0.15                              | 0.57 ± 0.23                            | 0.323   |
| Ventricular                  | 0.49 ± 0.34                              | 0.48 ± 0.18                            | 0.747   |
| Pulse width, ms             |                                         |                                        |         |
| Atrial                      | 0.5 (0.5–0.5)                            | 0.5 (0.475–0.5)                        | 0.485   |
| Ventricular                  | 0.5 (0.5–0.5)                            | 0.5 (0.5–0.5)                          | 0.355   |
| Sensitivity, mV             |                                         |                                        |         |
| Atrial                      | 4.3 (3.750–5.5)                          | 3.8 (2.875–6.2)                        | 0.255   |
| Ventricular                  | 14.09 ± 6.50                             | 15.27 ± 7.14                           | 0.406   |
| Electrode impedance, Ω      |                                         |                                        |         |
| Atrial                      | 692 ± 178                                | 804 ± 275                              | 0.289   |
| Ventricular                  | 746 ± 267                                | 808 ± 285                              | 0.289   |
| Other = AAI, V = volts; mV = millivolts; ms = millisecond; Ω = ohms; ΚΩ = kilo-ohms; A = amperes; bpm = beats per minute; DDD = dual-chamber pacemaker; VVI = single-chamber pacemaker. |

Table 3. Characteristics of patients who received implantable cardioverter defibrillators

| Characteristics              | Patients with re-used ICDs (cases) | Patients with new ICDs (controls) | n-value |
|-----------------------------|------------------------------------|-----------------------------------|---------|
| Sample size, n              | 12                                 | 12                                |         |
| Age                         | 49.83 ± 17.34                      | 50.58 ± 17.27                     | 0.916   |
| Gender, n (%)               |                                    |                                   |         |
| Male                        | 10 (83.3)                          | 10 (83.3)                         |         |
| Female                      | 2 (16.7)                           | 2 (16.7)                          |         |
| Co-morbidities, n (%)       |                                    |                                   |         |
| Hypertension                | 4 (33.3)                           | 4 (33)                            | 1.00    |
| Diabetes mellitus           | 1 (8.3)                            | 2 (16.7)                          | 0.537   |
| Renal impairment            | 8 (66.7)                           | 6 (50)                            | 0.408   |
| Cancer                      | 0 (0)                              | 0 (0)                             |         |
| Myocardial infarction       | 7 (58.3)                           | 4 (33.3)                          | 0.49    |
| Cardiomyopathy              | 3 (25)                             | 2 (1.7)                           | 1.00    |
| CVA                         | 1 (8.3)                             | 1 (8.3)                           | 1.00    |
| COPD                        | 2 (1.7)                            | 0 (0)                             | 0.48    |
| Dementia                    | 0 (0)                              | 0 (0)                             |         |
| Baseline function, n (%)    |                                    |                                   |         |
| NYHA functional class 1     | 1 (8.3)                            | 5 (41.7)                          | 0.20    |
| NYHA functional class 2     | 7 (58.3)                           | 7 (58.3)                          | 1.00    |
| NYHA functional class 3     | 4 (33)                             | 0 (0)                             | 0.11    |
| Wheelchair bound            | 0 (0)                              | 0 (0)                             |         |
| Bed bound                   | 0 (0)                              | 0 (0)                             |         |
| Ventricular tachycardia, n% | 9 (75)                             | 10 (83.3)                         | 0.615   |
| Other, n (%)                | 3 (25)                             | 2 (16.7)                          | 0.615   |
| First implantation, n (%)   | 12 (100)                           | 11 (91.7)                         | 0.307   |
| Battery change, n (%)       | 0 (0)                              | 1 (8.3)                           | 0.307   |
| Primary Implanter, n (%)    |                                    |                                   |         |
| Cardiologist                | 11 (91.7)                          | 12 (100)                          | 1.00    |
| Cardiology registrar        | 1 (8.3)                            | 0 (0)                             |         |
| Follow up at 3 months, n (%)| 12 (100)                           | 12 (100)                          | 1.00    |
| No                          | 0 (0)                              | 0 (0)                             |         |
| Follow up at 1 year, n (%)  | 12 (100)                           | 11 (91.7)                         | 0.307   |
| No                          | 0 (0)                              | 1 (8.3)                           |         |
| CVA = cerebrovascular accident; COPD = chronic obstructive pulmonary disease; NYHA = New York Heart Association; AV block = atrioventricular block; n = number; (%) = percentage; Other = ventricular fibrillation and arrhythmogenic right ventricular cardiomyopathy. |

For the ICD group, there was one device in the re-used device group that delivered inappropriate shocks (inappropriate delivery of shocks for supraventricular tachycardia), during the early stages of implantation but this resolved without any intervention. This device subsequently needed generator replacement after 14 months from implantation. There were no device infections identified after a median follow up of 35.9 months (IQR, 17.0–70.9 months) for the cases and 45.7 months (IQR, 37.6–53.7 months) for the controls. There were no procedure-non-related infections documented for the follow-up period.

For the ICD cases, five (41.7%) patients were followed up for five years or more, and seven (13.7%) for less than a year.

In the ICD group, there was one device in the re-used device group that delivered inappropriate shocks (inappropriate delivery of shocks for supraventricular tachycardia), during the early stages of implantation but this resolved without any intervention. This device subsequently needed generator replacement after 14 months from implantation. There were no device infections identified after a median follow up of 35.9 months (IQR, 17.0–70.9 months) for the cases and 45.7 months (IQR, 37.6–53.7 months) for the controls. There were no procedure-non-related infections documented for the follow-up period.

For the ICD group, there was one device in the re-used device group that delivered inappropriate shocks (inappropriate delivery of shocks for supraventricular tachycardia), during the early stages of implantation but this resolved without any intervention. This device subsequently needed generator replacement after 14 months from implantation. There were no device infections identified after a median follow up of 35.9 months (IQR, 17.0–70.9 months) for the cases and 45.7 months (IQR, 37.6–53.7 months) for the controls. There were no procedure-non-related infections documented for the follow-up period.

For the ICD cases, five (41.7%) patients were followed up for five years or more, and seven (13.7%) for less than a year.

For the ICD controls, seven (58.3%) were followed up for five years or more, and five (41.7%) for one to five years. In both groups (pacemaker and ICD) there were no devices explanted for infection or malfunctioning during the follow-up period.

In the re-used pacemaker group, 26 (51%) patients attended follow up at three months, whereas 25 (49%) did not attend. Of those who did not attend, 11 (44%) had died, nine (36%) were alive, and five (20%) were lost to follow up (Fig. 2). Of those who did die, eight (72.7%) were documented to have died from natural causes, one (9.1%) from cancer and two (18.2%) from non-pacemaker-related sepsis, of whom one died within 24 hours of implantation and the other after two months of implantation. The patient who died within 24 hours of device implantation was admitted with a methicillin-resistant Staphylococcus aureus (MRSA) endocarditis prior to pacemaker implantation.

In the new pacemaker group, 43 (84.3%) patients attended follow up at three months, whereas eight (15.7%) did not attend follow up. Of those who did not attend, one (12.5%) had died and seven (87.5) were alive (Fig. 2). The patient who died was an 87-year-old man who passed away at home two days after pacemaker implantation from natural causes.

In the re-used pacemaker group, at one-year follow up, 19 (37.3%) patients attended follow up, whereas 32 (62.7%) did not attend follow up. Of those who did not attend follow up, 15 (46.9%) had died, nine (28.1%) were alive, and eight (25%) were lost to follow up (Fig. 2). All deaths were due to natural causes except the two who were septic, mentioned above.

For the new pacemaker group, 38 (74.5%) patients attended follow up while 13 (25.5%) patients did not attend follow up at one year. Of those who did not attend follow up, three (23.1%) had died, seven (53.8%) were alive and three (23.1%) were lost to follow up (Fig. 2). All deaths were due to natural causes.
In the ICD group, there was 100% attendance for both cases and controls at three months’ follow up. At the one-year follow up, there was 100% attendance for the cases compared to 91.7% for the controls, with one (8.3%) patient absent. However, this patient had been discharged from Groote Schuur Hospital at three months of follow up, to be followed in Port Elizabeth, and was still alive at the time of publication (Fig 2).

**Discussion**

This study shows that the re-use of pacemakers and ICDs was feasible and safe in our group of patients at Groote Schuur Hospital in Cape Town, South Africa. There was no difference in the incidence of device infection, malfunction, battery failure or explantation due to complications between re-used and new devices. Indeed, device implantation was associated with no complications in this series.

To the best of our knowledge this is the second study ever published of the outcomes of re-used ICDs.\(^2^4\) In our study, there were no identified device infections and/or devices explanted for malfunction. There were no patients who were lost to follow up in this group.

Linde et al.\(^2^2\) in a retrospective case–control study, found no significant difference in device infection, although paradoxically,

| Parameters               | Patients with re-used ICDs (cases) | Patients with new ICDs (controls) | p-value |
|--------------------------|------------------------------------|-----------------------------------|---------|
| VVI, n (%)               | 12                                 | 12                                | 1.00    |
| Minimum pacing rate, bpm | 38.1 ± 4.7                         | 44.4 ± 9.4                        | 0.052   |
| Ventricular pacing, %    | 12                                 | 12                                | 1.00    |
| Capture Amplitude, V     | 0.618 ± 0.28                       | 0.708 ± 0.32                      | 0.481   |
| Ventricular Sensitivity, mV | 12.925 ± 6.93                 | 16.118 ± 6.17                     | 0.258   |
| Output Amplitude, V      | 3.5 (3.3–3.875)                    | 3.5 (3–3.5)                       | 0.875   |
| Ventricular Electrode impedance, Ω | 784.75 ± 304            | 648.83 ± 147                      | 0.177   |

V = volts; mV = millivolts; ms = milliseconds; Ω = ohms; KΩ = kilo-ohms; A = amperes; bpm = beats per minute; VVI = single-chamber device.
more infections were found in the new pacemaker group (7%) than in the re-used pacemaker group (2%). Kantharia et al. found no significant complications in an Indian study cohort of 53 patients who received cadaveric donated re-sterilised pacemakers over a mean follow up of 661 days.

Panja et al. found no difference in infection rates between the new pacemaker group and cadaveric donated re-usable pacemakers. However, higher rates of infection were found on infected re-sterilised devices that were implanted in the same patient, which were taken out and implanted on the opposite side. They attributed this higher infection rate to haematogenous or lymphatic spread from the previously infected pocket. Rosengarten et al. also found no significant difference in major pacemaker-related complications and reported that re-use of devices is cost effective.

Pavri et al., in a retrospective, single-centre cohort study of re-sterilised ICDs found no device-related infections, and 60.4% re-used ICDs delivered life-saving shocks. Baman et al. in a meta-analysis of 18 studies, found no significant difference in infection rates between the new device group and the re-used device group, but much higher device malfunction was associated with re-used devices compared to new devices. This malfunction was attributed to abnormality in the set screws.

In a recent study, Nava et al. found no significant difference in infection rates between re-used and new devices, although more infections were found in the new device group. They also found more device malfunction in the re-use device group, which was similar to the above studies, and the fault was also attributed to faulty pacemaker screws.

Device infection is thought to be associated with mortality rates between 2.6 and 18%. However studies that examined this issue showed no significant difference in infection or mortality rates between re-used and new device implantation. In our study we did not compare mortality rates between the two groups because of the selection bias of those who received a re-used pacemaker.

From the findings of this study and also acknowledging its limitations, pacemaker and ICD re-use is feasible and safe. It is a reasonable option for those who cannot afford new devices, provided that proper selection and sterilisation measures of re-used devices are followed. In the developing world, where there are major resource constraints, this option should be explored for the benefit of those suffering from symptomatic bradycardiac and life-threatening tachyarrhythmias.

We acknowledge several limitations of our study. First, this was a retrospective study with a small sample size of cases with re-used pacemakers and ICDs. Second, the follow-up period of patients with re-used devices was relatively short, with a median period of 15 months, with a significant number of patients who died within three months of device insertion. Finally, the patients who were selected for re-used pacemakers had significant co-morbidities, which were associated with a shortened life-span. These factors may limit the generalisability of the study, and call for appropriate prospective studies to answer this question.

Conclusion
Pacemaker and ICD re-use is feasible and safe in the short term (i.e. over months) provided that the devices for re-use are selected carefully and proper sterilisation methods are followed. Re-used pacemakers and ICDs are a realistic option for patients with co-morbidities who live in developing countries where there is limited access to pacemakers and ICDs.

References
1. Tracy CM, Ebstein AE, Darbar D, et al. 2012 ACCF/AHA/HRS focused update of the 2008 guidelines for device-based therapy of cardiac rhythm abnormalities: A report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines and Heart Rhythm Society. Circulation 2012; 126: 1784–1800.
2. Baman TS, Krikpatrick JN, Eagle KA, et al. Re-use of pacemakers and defibrillators in developing countries: logistical, legal, and ethical barriers and solutions. Heart Rhythm 2010; 7: 1623–1627.
3. Baman TS, Krikpatrick JN, Lange DC, et al. Pacemaker reuse: an initiative to alleviate the burden of symptomatic bradycardia in impoverished nations around the world. Circulation 2010; 122: 1649–1656.
4. Mayosi BM, Millar RNS. The 1995 survey of cardiac pacing in South Africa. S Afr Med J 1998; 88(suppl 4): C207–C213.
5. Mayosi B M, Scott Millar RN. Permanent cardiac pacing in Africa. East Afr Med J 2000; 77: 339.
6. Mond HG, Proclemer A. The 11th World Survey of Cardiac Pacing and Implantable Cardioverter-Defibrillators: calendar year 2009 – A World Society of Arrhythmia’s project. PACE 2011; 34: 1013–1027.
7. Hussain M, Balsara KP, Nagral S. Reuse of single-use devices: looking back, looking forward. Natl Med J India 2012; 25: 151–155.
8. Myers GH. Is reuse financially worthwhile? Pacing Clin Electrophysiol 1986; 3 pt 2: 1288–1294.
9. Ryden L. Re-use of devices in cardiology: proceedings from a policy conference at the European Heart House, 5–6 February, 1998. Eur Heart J 1999; 19: 1628–1631.
10. Hailey D, Jacobs PD, Ries NM, Polsensa J. Reuse of single use medical devices in Canada: clinical and economic outcomes, legal and ethical issues, and current hospital practice. Int J Technol Assess Health Care 2008; 24: 430–436.
11. Alfa MJ, Castillo J. Impact of FDA policy change on the reuse of single-use medical devices in Michigan hospitals. Am J Infect Control 2004; 32: 337–341.
12. Catanchin A, Murdock CJ, Athan E. Pacemaker infections: a 10-year experience. Heart Lung Circ 2007; 16: 434–439.
13. Villamil Cajito I, Rodriguez Framil M, van den Eynde Collado A, Jose Villacian Vicedo M, Canedo Romero C. Permanent transvenous pacemaker infections: an analysis of 59 cases. Eur J Intern Med 2007; 18: 484–488.
14. Baman TS, Gupta SK, Valle JA, Yamada E. Risk factors for mortality in patients with cardiac device-related infection. Circ Arrhythm Electrophysiol 2009; 2: 129–134.
15. Grendahi H. Pacemaker re-use. Tidskr Nor Legeforen 1994; 114: 3420–3423.
16. Pescaroli S, Stiubel M, Cozma D, Ioanovici T, Branea H, Luca CT, et al. La re utilisation des pacemakers, une alternative pour les personnes a ge'es de munies: etude re prospective. Stimmconer 2003; 31: 186–189.
17. Mugica J, Duonge R, Henry L. Survival and mortality in 3,701 pacemaker patients: arguments in favor of pacemaker reuse. Pacing Clin Electrophysiol 1986; 9(pt 2): 1282–1287.
18. Sethi KK, Bhargava M, Pandit N, Mohan JC, Arora R, Khanna SK, Kahlilullah M. Experience with recycled cardiac pacemakers. Indian Heart J 1992; 44: 91–93.
19. Gakenheimer L, Lange DC, Romero J, et al. Societal views of pace-
maker reutilization for those with untreated symptomatic bradycardia in underserved nations. J Interv Card Electrophysiol 2011; 30: 261–266.
20. Hughey AB, Baman TS, Kirkpatrick JN, Crayford TC, et al. Heart Rhythm Society Members’ views on pacemaker and implantable cardioverter-defibrillator reuse. PACE 2014; 37: 1–9.
21. Gakenheimer L, Crayford TC, Romero J, Baman TS, et al. Cardiac implantable electronic device reutilization: Battery life of explanted devices at a tertiary care center. PACE 2014; 37: 569–575.
22. Linde CL, Bocray A, Jonsson H, Rosenqvist M, Rådegran K, Rydén L. Re-used pacemakers: as safe as new? A retrospective case-control study. Eur Heart J 1998; 19: 154–157.
23. Nava S, Morales JL, Jose L, et al. Reuse of pacemakers: comparison of short and long-term performance. Circulation 2013; 127: 1177–1183
24. Pavri BB, Lokhandwala Y, Kulkarni GV, Shah M, Kantharia BK, Mascarenhas DA. Reuse of explanted, resterilized implantable cardioverter-defibrillators: a cohort study. Ann Intern Med 2012; 157(8): 542–548.
25. Kantharia BK, Patel SS, Kulkarni G, Shah AN, Lokhandwala Y, Mascarenhas E, Mascarenhas DA. Reuse of explanted permanent pacemakers donated by funeral homes. Am J Cardiol 2012; 109: 238–240.
26. Panjwani M, Sarkar CN, Kumar S, Kar AK, Mitra S, Sinha DP, et al. Reuse of pacemaker. Indian Heart J 1996; 48: 677–680.
27. Rosengarten M, Chiu R, Hoffman R. A prospective trial of new versus refurbished cardiac pacemakers: a Canadian experience. Can J Cardiol 1989; 5: 155–160.
28. Baman TS, Meier P, Romero J, Gakenheimer L, Kirkpatrick JN, Sovitch P, et al. Safety of pacemaker reuse: a meta-analysis with implications for underserved nations. Circ Arrhythm Electrophysiol 2011; 4: 318–323.

THE SOUTH AFRICAN JOURNAL OF Diabetes & Vascular Disease

This peer-reviewed journal is available as full text at all tertiary institutions in South Africa, presenting a great opportunity to submit your good-quality original articles for speedy publication.

Recent user research has shown that some 10 000 annual topic searches were done on the SA Journal of Diabetes & Vascular Disease database, which contains seven years of published material.

The SA Journal of Diabetes & Vascular Disease aims to provide a forum for specialists involved in the care of people with diabetes, to exchange information, promote better management and stimulate research in Africa.

This quarterly journal publishes original research and scholarly reviews about prevention and management of diabetes, relating to both general and specific issues.

The SA Journal of Diabetes & Vascular Disease invites you to submit your articles online only. Read the Instructions to Authors at www.diabetesjournal.co.za for more information on the journal’s policies and the submission process.