Journal of Cardiopulmonary Rehabilitation and Prevention

Exercise Based Cardiac Rehabilitation: Is a Little Encouragement Enough?

--Manuscript Draft--

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Response to Reviewers:	“More detail is needed about the ‘patients from an existing CR program’ (ex. what phase)”: Thank you for the suggestion. Both groups of patients were completing a phase III (early out-patient) programme, and this has been clarified both in the methods section and in the additional supplemental file. Page number: 2/line number: 49. “The calculation of HRR must be provided, including how maximal HR was determined. Likewise, the procedure used to determine HRWSI needs to be provided. Note, additional methodological information can be provided (including references) in a supplemental digital content file (any additional references used with the supplement do not appear in the manuscript reference list). This file would also then allow a more detailed explanation of the feedback procedures.”: Thank you for giving us the opportunity to expand further on these aspects in both the manuscript and in the supplementary file. We have added the requested methodological information in the research letter, and in the additional supplemental file we have expanded on how HRR, HRmax and HRWSI were calculated. Page number: 3/line number: 49. “This statement in the discussion is out of context “If this programme does represent the general pattern of delivery of other UK programmes” as the introduction does not suggest anything specific to the delivery of CR in the UK. Please make this statement more generic. One suggestion would be to reference this statement from the AACVPR (https://journals.lww.com/jcrjournal/Fulltext/2018/05000/Progression_of_Exercise_Training_in_Early.1.aspx) which emphasizes the need to progress the exercise intensity of CR participants. Likewise broadening the scope would suggest also referencing the American CR Core Components for CR (https://journals.lww.com/jcrjournal/Fulltext/2007/05000/Core_Components_of_Cardiac.

	1.aspx) along with your reference #5. :Thank you for highlighting this. The previous discussion statement has been removed and been replaced by a more generic one; the new statement, as you suggested, makes reference to AACVPR to emphasize that one of the reasons patients were not able to meet the minimum exercise intensity and duration targets may be due to the lack of manipulation of the progressive overload principle; namely, exercise intensity and duration. Page number: 5/line number: 54. Reference 8 is not necessary and can be removed. :Thank you for the suggestion however we feel that this reference (Reference 8) is to the ACPICR standards for physical activity and exercise in the cardiovascular population and details the exercise guidelines for UK cardiac rehabilitation programmes. Broadening the scope of the discussion has led to a statement on how UK cardiac rehabilitation programmes normally progress patients which is via increasing time spent exercising their cardiovascular system and dismissing active recovery time which is referenced in the ACPICR standards. Page number: 6/line number: 1. “Please consider revising the end of the conclusion (“We propose that with more frequent encouragement this may succeed to achieving the required exercise dose in each training session. This needs to be tested by a suitable powered RCT.”). Please consider that either enhanced supervision/monitoring of patients to assure they are exercising in the prescribe range is also a reasonable option. Additional encouragement, while also relevant for home-based programs, is not the sole approach that can work.”: The discussion has been revised to include your suggestions. Page number: 6/line number: 28. Please review the JCRP Instructions for Authors and the JCRP Style Guide (ex. abbreviations for units of measure (mins should be min); use of symbols in place of text [ex. > in place of minimum); use / in place of ‘per’; remove 0 before the decimal in P values for JCRP specific formatting. Also, please do a spell-check using the US English version.: We have reviewed the JCP instructions for Authors and have made the relevant changes throughout the research letter. Page number: throughout/line number: throughout. Please spell out each abbreviation at first use (must be used > 5 times in the manuscript): Abbreviations throughout the research letter were checked and only used if the full word had been used more than 5 times. Page number: throughout/line number: throughout. Please use the Journal preferred term ‘cardiorespiratory fitness’ in place of aerobic fitness. : This has now been amended. Page number: throughout/line number: throughout. In the Table report values as n (%), ex. 36 (12) with the footnote; Data are presented as mean ± SD or n (%). Please format the units in Table as follows: HRR, min and abbreviate weeks as wk. : This has now been amended. Page number: 4/line number: N/A (Table 1). Please remove doi from references unless the article is only available in an online format.: This has been addressed. Page numbers: 6-8/line numbers: throughout pages 6-8.

Cover Letter

All authors have read and approved submission of the manuscript and the manuscript has not been published and is not being considered for publication elsewhere in whole or part in any language except as an abstract.

The manuscript was proofed and edited by a native-English speaker and/or an editing service.

All authors meet the 4 ICMJE criteria for authorship.

All authors declare no conflicts of interest.

No financial support is also declared.

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Corresponding Author: Chelsea Moore

Manuscript Title: Exercise Based Cardiac Rehabilitation: Is a Little Encouragement Enough?

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Research Letter

Title: Exercise Based Cardiac Rehabilitation: Is a Little Encouragement Enough?

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INTRODUCTION

Since the publication of the first systematic review in the late 1980's [1] the efficacy rationale for cardiac rehabilitation (CR) has evolved from a singular outcome of all-cause mortality to additional multiple outcomes including cardiac mortality, quality of life , cardiorespiratory fitness, and cost savings in the form of preventing hospital re-admissions [2]. In the past decade, the case for the efficacy of reduced all-cause mortality has been challenged [3,4] but two questions arise around this matter: firstly, has some of the effective potency of exercise-based CR been lost due to the much more aggressive nature of modern cardiovascular health promotion and standards of medical, pharmacological and surgical interventions being much improved [5]? Secondly, in research trials and in practice has sufficient fidelity to an appropriate exercise dose been achieved, especially in those reports that have challenged the efficacy of CR [4]? In light of these questions, there has been a contemporary move to substantiate the efficacy of CR based on reduced hospital re-admissions, healthcare costs, and quality of life [2]. Given that a number of reviews, letters to editors, post-hoc trial and audit-data analyses have raised the question of exercise programme dose fidelity [6,7], the aim of the current study was to investigate the influence of exercise fidelity on measures of cardiorespiratory fitness (incremental shuttle-walk test and heart rate walking speed index/HRWSI), when patients were actively encouraged to achieve exercise intensities above 50% heart rate reserve (HRR).

METHODS

Following NHS ethics approval, patients from an existing phase III (early out-patient) CR programme were recruited to a group receiving either the normal exercise supervision (non-encouraged) (32 Male: 62.2 ± 11.7 yrs; 9 Female, 66.7 ± 7.8 yrs) or those receiving verbal encouragement to achieve an intensity >50% HRR (verbally encouraged) (9 Male: 66.9 ± 11.2 yrs; 2 Female: 72.5 ± 20.5 years) to ensure patients were exercising well within the

prescribed intensity guidelines [8]. The verbal encouragement was provided by a member of the research team at each of the aerobic exercise stations in sessions 2 (wk 1), 6 (wk 3) and 11 (wk 6). Patients in both groups completed the incremental shuttle-walk test pre- and post-programme. In addition to distance covered, changes in cardiorespiratory fitness were assessed using the HRWSI [9]. The HRWSI aims to show improvements in cardiorespiratory fitness more objectively through a lower heart rate (HR) for any given walking speed; a kind of "cardiac economy" which is independent of the distance walked. HRWSI was calculated by dividing peak heart rate by walking speed (in metres per minute) (attained in the last full one-minute of the incremental shuttle-walk test) and multiplied by 10 to express as HR per 10m walked. During all sessions, continuous heart-rate monitoring was used to determine achieved % HRR via a wireless chest-strap system (Polar RS800CX, Polar Electro, Finland). To determine HRR, measured resting HR was subtracted from maximal HR, which was estimated using the Inbar formula.

RESULTS

Exercise heart rates between 40-70% HRR (for at least 20 min) were achieved by 36%, 48% and 18% of participants in the non-encouraged group, and 36%, 33% and 57% of the verbally encouraged group, in weeks 1, 3 and 6 respectively. There were no differences between groups in the time spent exercising <40%, 40-49%, 50-59%, 60-70% and >70% of HRR ($P > .05$). On average neither of the groups attained exercising between 40-70% HRR for >20 min during the 6 weeks (Table 1) nor did any group complete an 8-week programme consisting of 16 supervised sessions. However, in the verbally encouraged group, there was a systematic progression of time spent at between 40-70% HRR from 12.4 ± 4.4 min at week 1 to 18.6 ± 4.1 min at week 6 (Table 1).

Table 1. Time spent performing exercise in respective HRR ranges in both groups.

Variable	Standard group not receiving encouragement				Group receiving encouragement				P value
	Wk 1 (n = 33)	Wk 3 (n = 29)	Wk 6 (n = 28)	Mean	Wk 1 (n = 11)	Wk 3 (n = 9)	Wk 6 (n = 7)	Mean	
<40% HRR[1] (min)	12.5 ± 11.3	7.3 ± 9.3*	10 ± 10.0*	9.3 ± 2.1	14.7 ± 13.7	9.8 ± 10.4*	10.4 ± 11.4*	11.6 ± 2.2	.29
40-49% HRR (min)	6.6 ± 5.3	6 ± 5.4	6.2 ± 6.2	6.3 ± 0.2	5.5 ± 5.4	5.1 ± 4.9	8.3 ± 5.5	6.3 ± 1.4	.86
50-59% HRR (min)	4.5 ± 4.2	5.1 ± 4.4	3.2 ± 3.2	4.3 ± 0.8	4.3 ± 4.5	4.9 ± 4.8	6.6 ± 4.0	5.3 ± 1.0	.95
60-70% HRR (min)	3 ± 4.2	4.5 ± 5.6	3 ± 3.2	3.5 ± 0.7	2.6 ± 3.3	4.5 ± 4.4	3.7 ± 2.8	3.6 ± 0.8	.64
>70% HRR (min)	3.4 ± 4.6	5.7 ± 8.0	6.4 ± 9.3	5.2 ± 1.3	3.1 ± 7.0	5.8 ± 8.9	2.4 ± 5.6	3.8 ± 1.5	.9
Total exercise time 40-70% HRR (min)	14.1 ± 4.6	15.6 ± 5.1	12.4 ± 4.2	14 ± 4.6	12.4 ± 4.4	14.5 ± 4.7	18.6 ± 4.1	15.2 ± 4.4	.8
Number and % of participants 40-70% HRR overall	12 (36)	14 (48)	5 (18)	34	6 (54)	6 (67)	5 (71)	64	n/a

[1] HRR, Heart rate reserve
Data are presented as mean ± SD or n (%).
P values represent between group differences
* Significantly different compared to week 1

Incremental shuttle-walk test distance improved in both groups compared to baseline where the verbally encouraged group increased by 186.4 ± 28.9 m and the non-encouraged group by 138.2 ± 98.7 m ($P < .01$). These improvements were, however, not significantly different from one another ($P > .05$). The change in HRWSI in the verbally encouraged group (-0.35 ± 1.4 beats per 10m walked) was significantly greater than the non-encouraged group (+0.54 ± 0.68 beats per 10m walked) ($P = .016$) but neither group showed a significant decrease compared to baseline ($P > .05$).

DISCUSSION

This study showed that some encouragement was not enough to get the verbally encouraged group to attain >20 min at 40-70% HRR per session. As verbal encouragement was only given during 3 sessions (25% of the programme duration), it is not known whether, in the remaining 75% of the exercise sessions, the patients were exercising at 40-70% HRR for 20 min, but it is assumed unlikely. However, unlike the non-encouraged group, those patients who were verbally encouraged, did show a systematic progression of increased duration of 4 min between 40-70% HRR at the end of week six. Whilst there were improvements in the incremental shuttle-walk test (increased walking distance), with no improvement in HRWSI, this was likely due to familiarisation/motivation or confidence in performing the tests and not a physiological adaptation [9].

Given that the required fidelity was not achieved in this CR programme, with a lower-than-recommended exercise dose resulting in lack of improvement in cardiorespiratory fitness, it would appear that the expected exercise potency was not achieved. One possible reason why patients did not achieve the recommended minimum intensity and duration (as per guidelines [8]) is the lack of progressive overload of exercise intensity and duration [10] which may also be the case in other UK CR programmes and across the globe. This highlights both the need for

exercise practitioners to spend more time encouraging patients to attain the minimum intensity/duration guidelines and service-provision as failure to do so may limit the benefits of exercise training for the patient. This programme aimed to progress patients via enhancing the duration spent in cardiovascular exercises and diminishing the duration of active recovery. Although we attempted to encourage patients to exercise >50% HRR for a few of their sessions, we did not up-titrate exercise intensity when patients achieved this, which is recommended in order to produce a training effect [11].

Previous trials have questioned the efficacy of CR in promoting improvements in mortality [3,4] but have not reported fully on the fidelity of the exercise programmes. This study has demonstrated that when fidelity is not achieved, it is unlikely that cardiorespiratory fitness of the patients will improve and consequently neither will other success indicators of the programme.

In conclusion, verbally encouraging patients to exercise above 50% HRR on few infrequent occasions meant that patients did not achieve the recommended exercise dose of ≥20 min at 40-70% HRR. However, compared to those who were not encouraged, the encouraged group showed a progression in the length of time exercising in the "right" intensity from week 1 to week 6. We propose that more frequent encouragement by the practitioners, and perhaps also monitoring of home-based exercise, may ensure that patients are exercising in the prescribed range of intensities, and may lead to successful achievement of the required exercise dose in each training session. This needs to be tested by a suitably powered randomised controlled trial.

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Research Letter

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Number of figures: 0

Number of references: ~~10~~ 11

INTRODUCTION

Since the publication of the first systematic review in the late 1980's [1] the efficacy rationale for cardiac rehabilitation (CR) has evolved from a singular outcome of all-cause mortality to additional multiple outcomes including cardiac mortality, quality of life ~~(QOL)~~, cardiorespiratory ~~aerobic~~ fitness~~, cost-effectiveness~~ and cost savings in the form of preventing hospital re-admissions [2]. In the past decade, the case for the efficacy of reduced all-cause mortality has been challenged [3,4] but two questions arise around this matter~~:;~~ firstly, has some of the effective potency of exercise-based CR been lost due to the much more aggressive nature of modern cardiovascular health promotion and standards of medical, pharmacological and surgical interventions being much improved [5]? Secondly, ~~has the fidelity~~ in research trials and in practice ~~of~~ has sufficient fidelity to an appropriate exercise dose ~~of the exercise~~ been achieved, especially in those reports that have challenged the efficacy of CR [4]? In light of these questions, there has been a contemporary move to substantiate~~ting~~ the efficacy of CR based on reduced hospital re-admissions, healthcare costs, and quality of life~~QOL~~ [2]. Given that a number of reviews, letters to editors, post-hoc trial and audit~~-~~data analysis have raised the question of exercise programme dose fidelity [6,7], the aim of the current study was to investigate the influence of exercise fidelity on measures of cardiorespiratory~~aerobic~~ fitness (incremental shuttle walk test~~/ISWT~~ and heart rate walking speed index/HRWSI), when patients were actively encouraged to achieve exercise intensities above 50% heart rate reserve (HRR).

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11.2 yrs; 2 Female: 72.5 ± 20.5 years) to ensure patients were exercising well within the prescribed intensity guidelines [8]. The verbal encouragement was provided by a member of the research team at each of the aerobic exercise stations in sessions 2 (wk 1), 6 (wk 3) and 11 (wk 6). Patients in both groups completed the incremental shuttle walk test~~ISWT~~ pre- and post-programme. In addition to distance covered, changes in cardiorespiratory fitness~~aerobic fitness~~ were assessed using the HRWSI [9]. The HRWSI aims to show improvements in cardiorespiratory~~aerobic~~ fitness more objectively through a lower heart rate (HR) for any given walking speed; a kind of "cardiac economy" which is independent of the distance walked. HRWSI was calculated by dividing peak heart rate by walking speed (in metres per minute) (attained in the last full one-minute of the incremental shuttle-walk test ~~ISWT~~) and multiplied by 10 to express as HR per 10m walked. During all sessions, continuous heart-rate monitoring was used to determine ~~exercise~~achieved ~~-%determine~~ HRR via a wireless chest-strap system (Polar RS800~~CX,Polar~~CX, Polar Electro, Finland). To determine HRR, measured resting HR was subtracted from maximal HR, which was estimated using the Inbar formula ~~first, 40-70% HRR was then calculated by subtracting the resting HR from maximal HR.~~

RESULTS

Exercise heart rates between 40-70% HRR (for at least 20 min) were achieved by 36%, 48% and 18% of participants in the non-encouraged group, and 36%, 33% and 57% of the verbally encouraged group, in weeks 1, 3 and 6 respectively. ~~At weeks 1, 3 and 6, 36%, 48% and 18%, of participants in the non-encouraged group achieved exercising between 40-70% HRR for 20 mins respectively. Similarly, at these same time points for the verbally encouraged group, 36%, 33% and 57% exercised between 40-70% for 20 or more mins.~~ There were no differences between groups in the time spent exercising <40%, 40-49%, 50-59%, 60-70% and >70% of HRR (P > ~~0~~.05). On average neither of the groups attained exercising between 40-

70% HRR for ~~a minimum of~~ >20 min~~s~~ during the 6 weeks (Table 1) nor did any group complete an 8-week programme consisting of 16 supervised sessions. However, in the verbally encouraged group, there was a systematic progression of time spent at between 40-70% HRR from 12.4 ± 4.4 min~~s~~ at week 1 to 18.6 ± 4.1 min~~s~~ at week 6 (Table 1).

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Variable	Standard group not receiving encouragement				Group receiving encouragement				P value
	Wkeek 1 (n = 33)	Wkeek 3 (n = 29)	Wkeek 6 (n = 28)	Mean	Wkeek 1 (n = 11)	Wkeek 3 (n = 9)	Wkeek 6 (n = 7)	Mean	
<40% HRR[1] (mins)	12.5 ± 11.3	7.3 ± 9.3*	10 ± 10.0*	9.3 ± 2.1	14.7 ± 13.7	9.8 ± 10.4*	10.4 ± 11.4*	11.6 ± 2.2	0.29
40-49% HRR (mins)	6.6 ± 5.3	6 ± 5.4	6.2 ± 6.2	6.3 ± 0.2	5.5 ± 5.4	5.1 ± 4.9	8.3 ± 5.5	6.3 ± 1.4	0.86
50-59% HRR (mins)	4.5 ± 4.2	5.1 ± 4.4	3.2 ± 3.2	4.3 ± 0.8	4.3 ± 4.5	4.9 ± 4.8	6.6 ± 4.0	5.3 ± 1.0	0.95
60-70% HRR (mins)	3 ± 4.2	4.5 ± 5.6	3 ± 3.2	3.5 ± 0.7	2.6 ± 3.3	4.5 ± 4.4	3.7 ± 2.8	3.6 ± 0.8	0.64
>70% HRR (mins)	3.4 ± 4.6	5.7 ± 8.0	6.4 ± 9.3	5.2 ± 1.3	3.1 ± 7.0	5.8 ± 8.9	2.4 ± 5.6	3.8 ± 1.5	0.9
Total exercise time 40-70% HRR (mins)	14.1 ± 4.6	15.6 ± 5.1	12.4 ± 4.2	14 ± 4.6	12.4 ± 4.4	14.5 ± 4.7	18.6 ± 4.1	15.2 ± 4.4	0.8
Number and % and number of participants 40-70% HRR overall	12 (36)36, 12	14 (48)48, 14	5 (18)18, 5	34	6 (54)54, 6	6 (67)67,6	5 (71)71,5	64	n/a

[1] HRR, Heart rate reserve
Data are is presented as mean ± SD or n (%).
P values represent between group differences
* Significantly different compared to week 1

Incremental shuttle--walkSWT test distance walked improved in both groups compared to baseline where the verbally encouraged group increased by 186.4 ± 28.9 m and the non-encouraged group by 138.2 ± 98.7 m ($P < 0.01$). These improvements were, however, not significantly different from one another ($P > 0.05$). The change in HRWSI in the verbally encouraged group (-0.35 ± 1.4 beats per 10m walked) were was significantly greater than the non-encouraged group (+0.54 ± 0.68 beats per 10m walked) ($P = 0.016$) but neither group showed a significant decrease compared to baseline ($P > 0.05$).

DISCUSSION

This study showed that some encouragement was not enough to get the verbally encouraged group to attain a minimum of >20 mins at 40-70% HRR per session. As verbal encouragement was only given during 3 sessions (25% of the programme duration), it is not known whether, in the remaining 75% of the exercise sessions, the patients were exercising at 40-70% HRR for 20 mins, but it is assumed unlikely. However, unlike the non-encouraged group, those patients who were verbally encouraged, did show a systematic progression of increased duration of 4 mins between 40-70% HRR at the end of week six. Whilst there were improvements in performance in the incremental shuttle--walk ISWT test (increased walking distance), with no improvement in HRWSI, this was likely due to familiarisation/motivation or confidence in performing the tests and not a physiological adaptation [9].

Given that the required fidelity of this CR programme was not achieved in this CR programme, with a lower-than-recommended exercise dose in terms of little or no differenceresulting in lack of improvement in cardiorespiratoryaerobic fitness as a result of a lower-than-recommended exercise dose, it would appear that the expected exercise potency was not achieved. One possible reason why patients did not achieve the recommended minimum intensity and duration (as per guidelines [8]) and thus, exhibited improvements in

~~cardiorespiratory fitness,~~ is~~may be~~ the lack of progressive overload of exercise intensity and duration [10] ~~If this programme does represent the general pattern of delivery of other UK programmes [4,11],~~ which may also be the case in other UK CR programmes and across the globe. This ~~then it~~ highlights both the need for exercise practitioners to spend more time encouraging patients to attain the minimum intensity/duration guidelines ~~(20 mins at 40-70% HRR)~~ and service-provision as failure to do so may limit the benefits of exercise training for the patient. ~~to better ensure this occurs on three or more times per week [8].~~ This programme aimed to progress patients via ~~enahcing~~enhancing the duration spent in~~of~~ cardiovascular exercises and diminishing the duration of active recovery. Although we attempted to encourage patients to exercise >50% HRR for a few of their sessions, we did not up~~-~~titrate exercise intensity when patients achieved this, ~~?? W~~which is recommended in order to produce a training effect [11].

~~offered two sessions per week, with a recommendation that patients attain their third dose of 20 mins in their own time. However, it is unknown if this was monitored by the CR team.~~

~~Considering that p~~Previous trials have questioned the efficacy of CR ~~to~~ in promot~~ing~~e improvements in mortality [3,4] but have not reported fully on the fidelity of the exercise programmes. ~~, th~~This study has ~~demonstrate~~demonstrated~~s~~ that when fidelity is ~~monitored and~~ not achieved, it is unlikely that cardiorespiratory~~aerobic~~ fitness of the patients will improve and consequently neither will other success indicators of the programme.~~.~~

In conclusion, verbally encouraging patients to exercise above 50% HRR on few infrequent occasions meant that patients did not achieve the recommended exercise dose of ≥20 min~~s~~ at ~~minimum ≥at~~ 40-70% HRR. However, compared to those who were not encouraged, the encouraged group showed a progression in the length of time exercising in the "right" intensity from week 1 to week 6. We propose that ~~with~~ more frequent encouragement by the

practitioners, and perhaps ~~enhanced~~also ~~-~~monitoring ~~even~~ of home-based exercise, may~~to~~ ensure that patients are exercising in the prescribed range of intensities, and may lead to ~~the~~ successful ~~of~~ ~~this may succeed to~~ achievement of~~ing~~ the required exercise dose in each training session. This needs to be tested by a suitably~~e~~ powered randomised controlled trial~~RCT~~.

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METHODS

VERBAL ENCOURAGEMENT FEEDBACK

Patients in the verbally encouraged group were monitored on all their cardiovascular exercise stations in the circuit class. If patients were not achieving an intensity >50% HRR, verbal feedback was provided such as “cycle a little bit faster” “can you go a little bit quicker on the rower please.”

DETERMINATION OF HR_{max}

Individual exercise intensities were calculated by the instructor prior to starting the phase III (early out-patient) CR programme. HR_{max} was estimated using the Inbar et al. [1] formula which is promoted by the UK Association of Chartered Physiotherapists in Cardiac Rehabilitation. See formula below with worked example:

$$HR_{max} = 205.8 - 0.685 \times age$$

$$HR_{max} = 205.8 – 0.685 \times 65 \text{ yrs} = 161 \text{ b·min}^{-1}$$

DETERMINATION OF HRR

HRR was calculated by subtracting the resting heart rate (measured by the cardiac nurse at the patients’ pre-assessment clinic) from the predicted HR_{max} [2]. In cases where patients were prescribed beta blocker medication, an additional 20 - 30 beats per minute (b·min^{-1}) was subtracted depending on the dosage of the beta blockade (see below for formula) with worked example:

$$HRR = HR_{max} – RHR - 20 - 30 \text{ (depending on ß-blocker dose)}$$

$$HRR = 161 – 58 – 20 = 83 \text{ b·min}^{-1}$$

Patients were given an exercise intensity range between 40 - 70% of HRR to exercise within throughout the main conditioning component. It is usual practice for patients to wear HR monitors for the first six sessions. To convert a given training HR to percent of HRR, the following formula was used:

$$HRR \times 0.4 + RHR = 40\% \text{ of HRR}$$

$$HRR \times 0.7 + RHR = 70\% \text{ of HRR}$$

Worked example:

$$40\% = 83 \times 0.4 + 58 = 91 \text{ b·min}^{-1}$$

$$70\% = 83 \times 0.7 + 58 = 116 \text{ b·min}^{-1}$$

DETERMINATION OF HRWSI

To calculate HRWSI, peak HR was divided by walking speed (in metres per minute) (attained in the last full one-minute of the intermittent shuttle-walk test and multiplied by 10 to describe heart beats per 10 m walked) [3].

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