

Clinical trials of CRT

TrialResults-center www.trialresultscenter.org

1 heart failure

Trial	Treatments	Patients	Trials design and methods
Combined CRT + ICD vs no CRT			
RethinQ , 2007 [NCT00132977] n=85/85 follow-up: 6 months	cardiac-resynchronization therapy ICD+CRT versus no cardiac-resynchronization therapy	patients with standard indication for an implantable cardioverter-defibrillator, NYHA 3, EF<35% , QRS<130ms, and evidence of mechanical dyssynchrony	Parallel groups open USA
CRT vs no CRT			
REVERSE , 2008 [NCT00271154].] n=419/191 follow-up: 12 months	CRT versus "placebo"	patients with NYHA functional class I or II heart failure with a QRS ≥ 120 ms and a LV ejection fraction $\leq 40\%$	Parallel groups double blind
MUSTIC-SR , 2001 n=58/58 follow-up: 3 months	CRT Medtronic/ELA medical versus CRT off	patients with severe heart failure (New York Heart Association class III) due to chronic left ventricular systolic dysfunction, with normal sinus rhythm and a duration of the QRS interval of more than 150 msec	Cross over Single blind
MIRACLE , 2002 n=228/225 follow-up: 6 months	CRT Medtronic versus CRT off	patients with moderate-to-severe symptoms of heart failure associated with an ejection fraction of 35 percent or less and a QRS interval of 130 msec	Parallel groups Bouble blind
PATH-CHF , 2002 n=NA follow-up: 1 month	CRT versus no CRT	patients with heart failure and ventricular conduction delay	Parallel groups open
MUSTIC AF , 2002 n=43/43 follow-up: 3 months	CRT Medtronic/ELA medical versus CRT off	patients with NYHA class III left ventricular systolic dysfunction, chronic atrial fibrillation, slow ventricular rate necessitating permanent ventricular pacing, and a wide QRS complex (paced width ≥ 200 ms)	Cross over Single blind
CARE-HF , 2005 n=409/404 follow-up: 29.4 months	CRT medtronic versus no CRT	patients with NYHA class III or IV heart failure due to left ventricular systolic dysfunction and cardiac dyssynchrony	parallel group open

continued...

Trial	Treatments	Patients	Trials design and methods
RD-CHF , 2003 n=NA follow-up:	CRT versus no CRT	patients with advanced heart failure	Parallel groups
COMPANION (CRT vs MT) , 2004 n=617/308 follow-up: 16 months	CRT guidant versus no CRT, optimized medical therapy	patients with advanced heart failure (NYHA III or IV) due to ischemic and non-ischemic cardiomyopathy with EF <=35% and QRS duration >120 ms	Parallel groups open
Garrigue , 2002 n=NA follow-up:	CRT versus no CRT	patients with chronic atrial fibrillation, severe heart failure and QRS prolongation of >or = 140 ms	Parallel groups single blind
Combined CRT + ICD vs no CRT no ICD			
AMIOVIRT , 2003 n=51/52 follow-up: 24 months	ICD versus amiodarone as medical therapy	patients with non ischemic cardiomyopathy with EF <=0.35 and Nonsustained ventricular tachycardia	Parallel groups open
COMPANION (CRT+ICD vs MT) , 2004 n=595/308 follow-up: 16 months	ICD+CRT versus no ICT no CRT, optimized medical therapy	patients with advanced heart failure (NYHA III or IV) due to ischemic and non-ischemic cardiomyopathy with EF <=0.35 and QRS duration >120 ms	Parallel groups open
Combined CRT + ICD vs CRT			
COMPANION (CRT+ICD vs CRT) , 2004 n=595/617 follow-up: 16 months	ICD+CRT versus CRT	patients with advanced heart failure (NYHA III or IV) due to ischemic and non-ischemic cardiomyopathy with EF <=0.35 and QRS duration >120 ms	Parallel groups open
Combined CRT + ICD vs ICD alone			
MIRACLE-ICD-II , 2004 n=85/101 follow-up: 6 months	ICD+CRT (and optimalmedical treatment) versus ICD (optimalmedical treatment)	NYHA class II heart failure patients on optimal medical therapy with a left ventricular (LV) ejection fraction <=35% , a QRS >=130 ms, and a class I indication for an ICD	Parallel groups double blind
MADIT CRT , 2009 [NCT00180271] n=1089/731 follow-up: 2 years	Cardiac resynchronization therapy with implantable cardioverter defibrillator versus implantable cardioverter defibrillator alone	patients with asymptomatic or mildly symptomatic heart failure (NYHA I/II), LEVF<=30% and QRS>=130ms	Parallel groups blinded United States, Europe

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Trial	Treatments	Patients	Trials design and methods
RAFT , 2010 [NCT00251251] n=894/904 follow-up: 40 months	ICD plus CRT versus ICD alone	patients with New York Heart Association (NYHA) class II or III heart failure, a left ventricular ejection fraction of 30% or less, and an intrinsic QRS duration of 120 msec or more or a paced QRS duration of 200 msec or more	Parallel groups double-blind Canada, Europe, Turkey, Australia
MIRACLE-ICD-I , 2003 n=187/182 follow-up: 6 months	ICD+CRT (plus optimal medical treatment) versus ICD (plus optimal medical treatment)	patients with NYHA class III or IV congestive HF despite appropriate medical management	Parallel groups double blind
CONTAK-CD , 2003 n=245/245 follow-up: 4.7 months	ICD+CRT versus ICD (no CRT)	patients with symptomatic heart failure, intraventricular conduction delay, and malignant ventricular tachyarrhythmias	Parallel groups open
CRT with triple site ventricular stimulation vs conventional cardiac resynchronization			
NCT00887237 <i>ongoing</i> n=NA follow-up:	CRT with triple site ventricular stimulation versus Conventional cardiac resynchronization	patients with NYHA Class III/IV heart failure	Parallel groups open

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More details and results :

- resynchronization (CRT) - defibrillators (ICD) for heart failure in patients with non ischaemic cardiomyopathy at <http://www.trialresultscenter.org/go-Q15>
- resynchronization (CRT) - defibrillators (ICD) for heart failure in all type of patients at <http://www.trialresultscenter.org/go-Q104>
- resynchronization (CRT) - defibrillators (ICD) for heart failure in mildly symptomatic heart failure with prolonged QRS interval at <http://www.trialresultscenter.org/go-Q349>

References

RethinQ, 2007:

Beshai JF, Grimm RA, Nagueh SF, Baker JH 2nd, Beau SL, Greenberg SM, Pires LA, Tchou PJ Cardiac-resynchronization therapy in heart failure with narrow QRS complexes. N Engl J Med 2007;357:2461-71 [17986493]

REVERSE, 2008:

Linde C, Abraham WT, Gold MR, St John Sutton M, Ghio S, Daubert C Randomized trial of cardiac resynchronization in mildly symptomatic heart failure patients and in asymptomatic patients with left ventricular dysfunction and previous heart failure symptoms. J Am Coll Cardiol 2008;52:1834-43 [19038680]

MUSTIC-SR, 2001:

Cazeau S, Leclercq C, Lavergne T, Walker S, Varma C, Linde C, Garrigue S, Kappenberger L, Haywood GA, Santini M, Bailleul C, Daubert JC Effects of multisite biventricular pacing in patients with heart failure and intraventricular conduction delay. *N Engl J Med* 2001;344:873-80 [11259720]

Duncan A, Wait D, Gibson D, Daubert JC Left ventricular remodelling and haemodynamic effects of multisite biventricular pacing in patients with left ventricular systolic dysfunction and activation disturbances in sinus rhythm: sub-study of the MUSTIC (Multisite Stimulation in Cardiomyopathies) trial. *Eur Heart J* 2003;24:430-41 [12633545]

MIRACLE, 2002:

Abraham WT, Fisher WG, Smith AL, Delurgio DB, Leon AR, Loh E, Kocovic DZ, Packer M, Clavell AL, Hayes DL, Ellestad M, Trupp RJ, Underwood J, Pickering F, Truex C, McAtee P, Messenger J Cardiac resynchronization in chronic heart failure. *N Engl J Med* 2002;346:1845-53 [12063368]

Barold H. Preliminary clinical review of Medtronic InSync MIRACLE PMA (Report) <http://www.fda.gov/cdrh/pdf/p010015.html>. (26 September 2005).

PATH-CHF, 2002:

Auricchio A, Stellbrink C, Sack S, Block M, Vogt J, Bakker P, Huth C, Schndube F, Wolfhard U, Becker D, Krahnfeld O, Kirkels H Long-term clinical effect of hemodynamically optimized cardiac resynchronization therapy in patients with heart failure and ventricular conduction delay. *J Am Coll Cardiol* 2002;39:2026-33 [12084604]

MUSTIC AF, 2002:

Leclercq C, Walker S, Linde C, Clementy J, Marshall AJ, Ritter P, Djiane P, Mabo P, Levy T, Gadler F, Bailleul C, Daubert JC Comparative effects of permanent biventricular and right-univentricular pacing in heart failure patients with chronic atrial fibrillation. *Eur Heart J* 2002;23:1780-7 [12419298]

CARE-HF, 2005:

Cleland JG, Daubert JC, Erdmann E, Freemantle N, Gras D, Kappenberger L, Tavazzi L The effect of cardiac resynchronization on morbidity and mortality in heart failure. *N Engl J Med* 2005;352:1539-49 [15753115]

RD-CHF, 2003:

Leclercq C, Cazeau S, Lellouche D, et al Upgrading from right ventricular pacing to biventricular pacing in previously paced patients with advanced heart failure: a randomized controlled study [the RD-CHF Trial] [Abstract] European Society of Cardiology Congress, Vienna, Austria, 30 August-3 September 2003

COMPANION (CRT vs MT), 2004:

Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50 [15152059]

Proestel S. Preliminary clinical review of COMPANION PMA (Report).pj <http://www.fda.gov/ohrms/dockets/ac/04/briefing/>. . . (26 September 2005).

Garrigue, 2002:

Garrigue S, Bordachar P, Reuter S, Jas P, Kobeissi A, Gaggini G, Hassaguere M, Clementy J Comparison of permanent left ventricular and biventricular pacing in patients with heart failure and chronic atrial fibrillation: prospective haemodynamic study. *Heart* 2002;87:529-34 [12010933]

AMIOVIRT, 2003:

Strickberger SA, Hummel JD, Bartlett TG, Frumin HI, Schuger CD, Beau SL, Bitar C, Morady F Amiodarone versus implantable cardioverter-defibrillator: randomized trial in patients with nonischemic dilated cardiomyopathy and asymptomatic nonsustained ventricular tachycardia-AMIOVIRT. *J Am Coll Cardiol* 2003;41:1707-12 [12767651]

COMPANION (CRT+ICD vs MT), 2004:

Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50 [15152059]

COMPANION (CRT+ICD vs CRT), 2004:

Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50 [[15152059](#)]

MIRACLE-ICD-II, 2004:

Abraham WT, Young JB, Len AR, Adler S, Bank AJ, Hall SA, Lieberman R, Liem LB, O'Connell JB, Schroeder JS, Wheelan KR Effects of cardiac resynchronization on disease progression in patients with left ventricular systolic dysfunction, an indication for an implantable cardioverter-defibrillator, and mildly symptomatic chronic heart failure. *Circulation* 2004;110:2864-8 [[15505095](#)]

MADIT CRT, 2009:

Moss AJ, Hall WJ, Cannom DS, Klein H, Brown MW, Daubert JP, Estes NA 3rd, Foster E, Greenberg H, Higgins SL, Pfeffer MA, Solomon SD, Wilber D, Zareba W Cardiac-Resynchronization Therapy for the Prevention of Heart-Failure Events. *N Engl J Med* 2009 Sep 1;: [[19723701](#)] [10.1056/NEJMoa0906431](#)

Goldenberg I, Kutyifa V, Klein HU, Cannom DS, Brown MW, Dan A, Daubert JP, Estes NA 3rd, Foster E, Greenberg H, Kautzner J, Klempfner R, Kuniss M, Merkely B, Pfeffer MA, Quesada A, Viskin S, McNitt S, Polonsky B, Ghanem A, Solomon SD, Wilber D, Zareba W, Survival with Cardiac-Resynchronization Therapy in Mild Heart Failure. *N Engl J Med* 2014 Mar 30;: [[24678999](#)] [10.1056/NEJMoa1401426](#)

RAFT, 2010:

Tang AS, Wells GA, Talajic M, Arnold MO, Sheldon R, Connolly S, Hohnloser SH, Nichol G, Birnie DH, Sapp JL, Yee R, Healey JS, Rouleau JL Cardiac-Resynchronization Therapy for Mild-to-Moderate Heart Failure. *N Engl J Med* 2010 Nov 14;: [[21073365](#)] [10.1056/NEJMoa1009540](#)

Sapp JL, Parkash R, Wells GA, Yetisir E, Gardner MJ, Healey JS, Thibault B, Sterns LD, Birnie D, Nery PB, Sivakumaran S, Essebag V, Dorian P, Tang AS Cardiac Resynchronization Therapy Reduces Ventricular Arrhythmias in Primary but Not Secondary Prophylactic Implantable Cardioverter Defibrillator Patients: Insight From the Resynchronization in Ambulatory Heart Failure Trial. *Circ Arrhythm Electrophysiol* 2017;10: [[28292754](#)]

MIRACLE-ICD-I, 2003:

Young JB, Abraham WT, Smith AL, Leon AR, Lieberman R, Wilkoff B, Canby RC, Schroeder JS, Liem LB, Hall S, Wheelan K Combined cardiac resynchronization and implantable cardioversion defibrillation in advanced chronic heart failure: the MIRACLE ICD Trial. *JAMA* 2003;289:2685-94 [[12771115](#)]

CONTAK-CD , 2003:

Higgins SL, Hummel JD, Niazi IK, Giudici MC, Worley SJ, Saxon LA, Boehmer JP, Higginbotham MB, De Marco T, Foster E, Yong PG Cardiac resynchronization therapy for the treatment of heart failure in patients with intraventricular conduction delay and malignant ventricular tachyarrhythmias. *J Am Coll Cardiol* 2003;42:1454-9 [[14563591](#)]

NCT00887237, :

ongoing trial

2 prevention of sudden death

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RD-CHF , 2003 n=NA follow-up:	CRT versus no CRT	patients with advanced heart failure	Parallel groups
COMPANION (CRT vs MT) , 2004 n=617/308 follow-up: 16 months	CRT guidant versus no CRT, optimized medical therapy	patients with advanced heart failure (NYHA III or IV) due to ischemic and non-ischemic cardiomyopathy with EF $\leq 35\%$ and QRS duration >120 ms	Parallel groups open
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Combined CRT + ICD vs no CRT no ICD			

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CONTAK-CD , 2003 n=245/245 follow-up: 4.7 months	ICD+CRT versus ICD (no CRT)	patients with symptomatic heart failure, intraventricular conduction delay, and malignant ventricular tachyarrhythmias	Parallel groups open
CRT with triple site ventricular stimulation vs conventional cardiac resynchronization			
NCT00887237 ongoing n=NA follow-up:	CRT with triple site ventricular stimulation versus Conventional cardiac resynchronization	patients with NYHA Class III/IV hert failure	Parallel groups open

More details and results :

- resynchronization (CRT) - defibrillators (ICD) for prevention of sudden death in primary prevention at <http://www.trialresultscenter.org/go-Q107>
- resynchronization (CRT) - defibrillators (ICD) for prevention of sudden death in heart failure at <http://www.trialresultscenter.org/go-Q109>

References

RethinQ, 2007:

Beshai JF, Grimm RA, Nagueh SF, Baker JH 2nd, Beau SL, Greenberg SM, Pires LA, Tchou PJ Cardiac-resynchronization therapy in heart failure with narrow QRS complexes. *N Engl J Med* 2007;357:2461-71 [17986493]

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Duncan A, Wait D, Gibson D, Daubert JC Left ventricular remodelling and haemodynamic effects of multisite biventricular pacing in patients with left ventricular systolic dysfunction and activation disturbances in sinus rhythm: sub-study of the MUSTIC (Multisite Stimulation in Cardiomyopathies) trial. *Eur Heart J* 2003;24:430-41 [12633545]

MIRACLE, 2002:

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Barold H. Preliminary clinical review of Medtronic InSync MIRACLE PMA (Report) <http://www.fda.gov/cdrh/pdf/p010015.html>. (26 September 2005).

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RD-CHF, 2003:

Leclercq C, Cazeau S, Lellouche D, et al Upgrading from right ventricular pacing to biventricular pacing in previously paced patients with advanced heart failure: a randomized controlled study [the RD-CHF Trial] [Abstract] European Society of Cardiology Congress, Vienna, Austria, 30 August-3 September 2003

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Proestel S. Preliminary clinical review of COMPANION PMA (Report).pj <http://www.fda.gov/ohrms/dockets/ac/04/briefing/>. . . (26 September 2005).

Garrigue, 2002:

Garrigue S, Bordachar P, Reuter S, Jas P, Kobeissi A, Gaggini G, Hassaguerre M, Clementy J Comparison of permanent left ventricular and biventricular pacing in patients with heart failure and chronic atrial fibrillation: prospective haemodynamic study. *Heart* 2002;87:529-34 [12010933]

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Strickberger SA, Hummel JD, Bartlett TG, Frumin HI, Schuger CD, Beau SL, Bitar C, Morady F Amiodarone versus implantable cardioverter-defibrillator: randomized trial in patients with nonischemic dilated cardiomyopathy and asymptomatic nonsustained ventricular tachycardia-AMIOVIRT. *J Am Coll Cardiol* 2003;41:1707-12 [12767651]

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Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50 [15152059]

COMPANION (CRT+ICD vs CRT), 2004:

Bristow MR, Saxon LA, Boehmer J, Krueger S, Kass DA, De Marco T, Carson P, DiCarlo L, DeMets D, White BG, DeVries DW, Feldman AM Cardiac-resynchronization therapy with or without an implantable defibrillator in advanced chronic heart failure. *N Engl J Med* 2004;350:2140-50 [15152059]

MIRACLE-ICD-II, 2004:

Abraham WT, Young JB, Len AR, Adler S, Bank AJ, Hall SA, Lieberman R, Liem LB, O'Connell JB, Schroeder JS, Wheelan KR Effects of cardiac resynchronization on disease progression in patients with left ventricular systolic dysfunction, an indication for an implantable cardioverter-defibrillator, and mildly symptomatic chronic heart failure. *Circulation* 2004;110:2864-8 [15505095]

MIRACLE-ICD-I, 2003:

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CONTAK-CD , 2003:

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NCT00887237, :

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