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Different recovery methods effect on lactic acid at various time intervals

Diksha and Deepak Mehta

Abstract
Growing sports competition had made greater impact on better resources of recovery. In the present study four different recovery methods i.e., Active Recovery, Passive Recovery, Contrast Bath and Cryotherapy on Lactic Acid at different time interval. For the purpose of this study forty (N=20, 5 subjects for each recovery methodology) male medium pacers were selected for study and given a selected load of repetitive 200-meter exercise. Repeated Measure Analysis of variance (R-ANOVA) was employed to determine significant difference at 0.05 level of significance in SPSS 20.0 Different recovery procedures affected lactic acid in this research. The most effective treatment for lowering lactic acid levels was the contrast bath therapy administered after the third and sixth minute. This was followed by active recovery and cryotherapy as the next most effective treatments. The findings of this study suggested coaches should organise contrast bath therapy sessions for better recovery of medium fast bowlers.

Keywords: Contrast bath, active & passive, cryotherapy, recovery and cricket

Introduction
When it comes to sports performance, the idea of recuperation is something that relaxation training and methods have become more important in. During the healing process, it is important to relax the sensitive organs and soft tissues of the body, such as the muscles. Some athletes discovered that it was difficult to discriminate between the many sorts of actions that they did that were within their own control. It is physically impossible to be both tight and calm at the same time. (Kaur, 2017) [17] During both active and passive recovery, Francaux *et al*. conducted research in the year 1995 to explore lactate metabolism. When going from passive recovery to moderate activity recovery, the rate at which lactate was removed from the body rose, but it reduced when going from moderate exercise recovery to intensive exercise recovery. Massage of the muscles is another way that researchers have investigated for the elimination of lactate. The generation of lactate was discovered to be varied in the work that was done on the study; athletes who play or run for a longer amount of time with shorter recovery intervals tend to create greater levels of lactate than athletes who play or run for shorter periods of time. It has been suggested that lactic acid, which is the end product of glycolysis under anaerobic conditions, may be one of the factors that contribute to the development of tiredness. The last result of anaerobic glycolysis, which involves the breakdown of glycogen into lactic acid in the absence of oxygen. The increased creation of blood lactate that occurs during training may be caused by an increase in the amount of heat that is produced inside the body and a decrease in the amount of heat that is lost from the body. (Francaux M, Jacqmin P. Micholette De Welle J & X., 1995) [3] The intensity and duration of training are two factors that influence how long it will take to recover, and the appropriateness of the recovery intervention is another factor that influences how long recovery will take. Inadequate recuperation leads to negative adaptation, and any discrepancy between recovery and training has the potential to result in a decline in an athlete's physical skills. The following means and method of recovery were selected for the study.

1. Cold-water Immersion
2. Contrast-water Immersion
3. Active Recovery
4. Passive Recovery

Cricket & Recovery

The body gets stressed out by any kind of physical activity, including cricket. The level of stress experienced by the body varies continuously. It's possible that after a jog of moderate intensity, all the body has to do is restore its glycogen (sugar) levels to where they were before the workout. This takes a number of hours. On the other hand, when the body is subjected to strong activity loads like weightlifting or bowling, it may need the management of metabolic processes in order to restore muscle and connective tissue or regenerate muscle and connective tissue. This might take many days. In most cases, the healing processes in question are asymptomatic and occur below the clinical threshold.

When given time to relax, the body is able to restore itself. When the stress placed on the body is greater than the capacity of the biological healing processes, physical breakdown or damage may occur. This degradation is often gradual and progressive in nature. Injury prevention requires careful management of both load and repair.

Stress is placed on more than only the muscles, joints, and bones. The systems that control the central nervous system and the immune system are responsible for regulating mental fatigue and hormonal balance. Due to the fact that the body is able to efficiently manage stress, players do not become aware of a problem until it is too late. What kinds of things do professional cricket players do to help their bodies rebalance themselves and reduce the amount of tension that builds up within them? There are a huge number of distinct actions that may be taken, some of which can be taken with more success than others. Some methods of therapy have been around since the beginning of time, while others are at the leading edge of medical technology but may be rather expensive. The objective of the study was to evaluate the efficacy of various recovery approaches (i.e., active recovery, passive recovery, contrast bath, and cryotherapy) based on a chosen physiological marker (i.e., lactic acid) of recovery at varying time intervals.

Methodology

Selection of Subject

Twenty (N=20) male medium pacers from the different cricket academies were selected as the subjects for this study. Medium pacers age was in between 15-17 years.

Study Design

In order to achieve the objective of the study, the scholar conducted repeated measure experiment to determine the best recovery method for selected junior medium fast bowlers. For this, selected subjected were divided into four different recovery methodology group with 5 subjects in each group.

Administration of Blood Lactate test

- **Purpose:** To measure the blood lactate concentration in the blood.
- **Equipment:** Lactate Meter
- **Procedure:** The strip was inserted in the blood lactate analyser and the blood was drawn after prickling by a lancing device. Little drop of the blood was putted on the test strip to know the level of the blood lactate level in the blood.
- **Score:** The Value shown in the blood lactate analyser as the concentration of blood lactate in mmol/L was recorded as individual score.

Administration of Training Load

- **Purpose:** To disturb the normal homeostasis of the body.
- **Equipment's:** 200 Meter Track, Stop Watch and Stethoscope
- **Procedure:** The subjects were asked to stand behind the restraining line. The subjects performed 3 sets with 5 repetitions of 200 meter at 90% load intensity with 90 seconds rest in between the two sets. (Clark M, Lucett S, McGill E, 2018)

Administration of Recovery Methodology

S. No.	Intervention	Time	Details
	Cold-Water Immersion	20 Minutes	Immersion of body till neck in cold with temperature at 10 to 15 ° Celsius
	Contrast Water Immersion	20 Minutes	Immersion of body till neck in cold and hot water. Cold Temperature- 15 ° Celsius Hot Temperature-38 ° Celsius
	Active Recovery	20 Minutes	5-minute slow jogging followed by static stretching of major muscles.
	Passive Recovery	-	No treatment will be given

Fig 1: Intervention schedule

Statistical analysis

Descriptive statistics and Repeated Measure Analysis of Variance (R-ANOVA) was used in IBM SPSS 20.0 to analyze the comparison of different recovery methodologies (i.e., Active Recovery, Passive Recovery, Contrast Bath and Cryotherapy) on the basis of selected physiological markers i.e., Lactic Acid of recovery at different time intervals. (Verma J P, 2013) [9].

Result

Table 1: Descriptive Statistics of Physiological Marker i.e., Lactic Acid for different selected recovery methods at different intervals of testing.

Timing of Test for Lactic Acid	Intervention given for recovery	Mean (mmol/L)	Std. Deviation
Pre-test before load intervention	Active Recovery	6.9200	1.81576
	Cryotherapy Ice Bath Method	5.1000	.74498
	Contrast Bath	7.1800	2.34030
	Passive Recovery	4.2800	.66106
Post-test after load intervention	Active Recovery	16.0200	2.67806
	Cryotherapy Ice Bath Method	17.6200	2.95076
	Contrast Bath	18.9200	2.54892
	Passive Recovery	18.4800	.59330
Test after 3 minutes of intervention	Active Recovery	15.2320	.56202
	Cryotherapy Ice Bath Method	15.3300	.52474
	Contrast Bath	13.1100	1.53168
	Passive Recovery	15.3920	.65036
Test after 6 minutes of intervention	Active Recovery	11.9100	.74290
	Cryotherapy Ice Bath Method	13.2640	1.53899
	Contrast Bath	7.9300	.79341
	Passive Recovery	12.5100	.64113
Test after 9 minutes of intervention	Active Recovery	6.9200	1.37732
	Cryotherapy Ice Bath Method	7.7000	1.16404
	Contrast Bath	3.7800	.97826
	Passive Recovery	4.1000	.70711

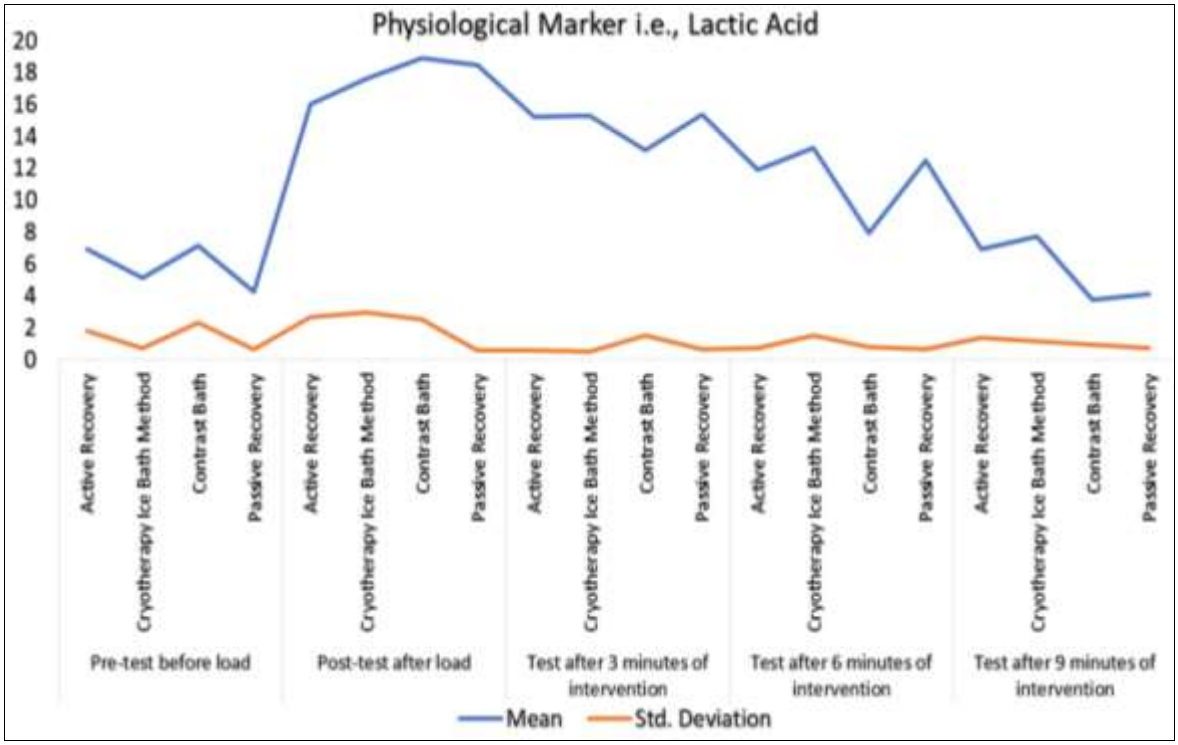

Fig 2: Bar chart for descriptive statistics of Physiological Marker i.e., Lactic Acid for different selected recovery methods at different intervals of testing

Table and Fig No. 1 represents the descriptive statistics i.e., mean and standard deviation of Lactic Acid before and after recovery method intervention at different time intervals of testing. Lactic Acid measurement at pre-test before load intervention for active recovery group, cryotherapy ice bath group, contrast bath group and passive recovery group was 6.92±1.81 mmol/L, 5.10±0.74 mmol/L, 7.18±2.34 mmol/L and 4.28±0.66 mmol/L respectively. Lactic Acid measurement at post-test after load intervention for active recovery group, cryotherapy ice bath group, contrast bath group and passive recovery group was 16.02±2.67mmol/L, 17.62±2.95 mmol/L, 18.92±2.54 mmol/L and 18.48±0.59 mmol/L respectively. Lactic Acid measurement at post-test after 3 minutes of intervention for active recovery group, cryotherapy ice bath group, contrast bath group and passive recovery group was 15.23±0.56mmol/L, 15.33±0.52 mmol/L, 13.11±1.53 mmol/L and 15.39±0.65 mmol/L respectively. Lactic Acid measurement at post-test after 6 minutes of intervention for active recovery group, cryotherapy ice bath group, contrast bath group and passive recovery group was 11.91±0.74 mmol/L, 13.26±1.53 mmol/L, 7.93±0.79 mmol/L and 12.51±0.64 mmol/L respectively. Lactic Acid measurement at post-test after 9 minutes of intervention for active recovery group, cryotherapy ice bath group, contrast bath group and passive recovery group was 6.92±1.37 mmol/L, 7.70±1.16 mmol/L, 3.78±0.97 mmol/L and 4.10±0.70 mmol/L respectively.

Table 2: Levene's Test of Equality of Error Variances for Physiological Marker i.e., Lactic acid at different intervals of testing.

	F	df1	df2	Sig.
Pre-test before load	1.172	3	16	.377
Post-test after load	2.218	3	16	.126
Test after 3 minutes of intervention	1.162	3	16	.355
Test after 6 minutes of intervention	2.640	3	16	.236
Test after 9 minutes of intervention	1.671	3	16	.213

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Recovery Method Within Subjects Design: Test

Table 2 represents the value of Levens test. The Levens is an assumption for R-ANOVA test for determining homogeneity of group. The obtained value for Levens test is 0.377, 0.126, 0.355, 0.236 and 0.213 which is more than 0.05 and hence the assumption of equality of variance is not violated. Thus, the null hypothesis of equality of population means of four treatment groups is rejected and it may be concluded that the recovery performance of selected treatment groups are different at different interval of testing.

Table 3: Mauchly's test of sphericity for selected Recovery Method i.e., Lactic Acid

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Test	.207	22.691	9	.007	.594	.836	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Recovery Method Within Subjects Design: Test

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Table No. 3 represents the Mauchly test of sphericity which tests the assumptions of variability across the repeated measure design. The obtained value was significant as p-value less than 0.05, hence assumption of sphericity was violated. In order to adjust the sphericity assumption Epsilon was noted for Greenhouse-Geisser (epsilon less than 0.75) as correction model.

Table 4: Tests of within-subjects' effects for recovery patterns, test points and their interaction on lactic acid recovery.

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Test	Sphericity Assumed	2304.293	4	576.073	274.422	.000	.945
	Greenhouse-Geisser	2304.293	2.378	969.086	274.422	.000	.945
	Huynh-Feldt	2304.293	3.344	689.032	274.422	.000	.945
	Lower-bound	2304.293	1.000	2304.293	274.422	.000	.945
Test * Recovery Method	Sphericity Assumed	180.098	12	15.008	7.149	.000	.573
	Greenhouse-Geisser	180.098	7.133	25.247	7.149	.000	.573
	Huynh-Feldt	180.098	10.033	17.951	7.149	.000	.573
	Lower-bound	180.098	3.000	60.033	7.149	.003	.573
Error(Test)	Sphericity Assumed	134.351	64	2.099			
	Greenhouse-Geisser	134.351	38.045	3.531			
	Huynh-Feldt	134.351	53.508	2.511			
	Lower-bound	134.351	16.000	8.397			

From table no. 4 it was evident that there was significant difference obtained for main effect of time of testing on lactic acid as obtained Greenhouse-Geisser p-value is less than 0.05 with partial eta square of 0.945 which means the variation in lactic acid is 94.5% explained by time interval of testing. For interaction effect of time and recovery methodology on lactic acid as obtained Greenhouse-Geisser p-value is less than 0.05 with partial eta square of 0.573% which means the variation in lactic acid is 57.3% explained by time interval of testing and recovery method together. Hence, pairwise comparison was done to determine significance of difference between the group and within the group at different time intervals of testing.

Table 5: Pairwise comparisons between overall recovery patterns of lactic acid recovery

(I) Intervention given for recovery	(J) Intervention given for recovery	Mean Difference (I-J)	Std. Error	Sig. [b]
Active Recovery	Cryotherapy Ice Bath Method	-.402	.468	1.000
	Contrast Bath	1.216	.468	.116
	Passive Recovery	.448	.468	1.000
Cryotherapy Ice Bath Method	Active Recovery	.402	.468	1.000
	Contrast Bath	1.619*	.468	.019
	Passive Recovery	.850	.468	.527
Contrast Bath	Active Recovery	-1.216	.468	.116
	Cryotherapy Ice Bath Method	-1.619*	.468	.019
	Passive Recovery	-.768	.468	.719
Passive Recovery	Active Recovery	-.448	.468	1.000
	Cryotherapy Ice Bath Method	-.850	.468	.527
	Contrast Bath	.768	.468	.719

Based on estimated marginal means

*. The mean difference is significant at the. 05 level.

b. Adjustment for multiple comparisons: Bonferroni.

From table no. 5 it can be concluded the there was no overall significant difference was obtained for selected recovery methodology. The value obtained for pairwise comparison were less than 0.05 (p<0.05, Mean Diff. 1.619) for between contrast bath and cryotherapy. Hence, overall contrast bath recovery method was having significant difference when compared to cryotherapy and no significant difference obtained for active, passive and contrast therapy.

Table 6: Pairwise comparisons between overall time intervals of testing of lactic acid recovery

(I) Test	(J) Test	Mean Difference (I-J)	Std. Error	Sig.[b]
Pre-test before load	post-test after load	-11.890*	.614	.000
	Test after 3 minutes of intervention	-8.896*	.473	.000
	Test after 6 minutes of intervention	-5.534*	.362	.000
	Test after 9 minutes of intervention	.245	.270	1.000
Post-test after load	pre-test before load	11.890*	.614	.000
	Test after 3 minutes of intervention	2.994*	.512	.000
	Test after 6 minutes of intervention	6.357*	.567	.000
	Test after 9 minutes of intervention	12.135*	.610	.000
Test after 3 minutes of intervention	pre-test before load	8.896*	.473	.000
	post-test after load	-2.994*	.512	.000
	Test after 6 minutes of intervention	3.363*	.316	.000
	Test after 9 minutes of intervention	9.141*	.359	.000
Test after 6 minutes of intervention	pre-test before load	5.534*	.362	.000
	post-test after load	-6.357*	.567	.000
	Test after 3 minutes of intervention	-3.363*	.316	.000
	Test after 9 minutes of intervention	5.779*	.333	.000
Test after 9 minutes of intervention	pre-test before load	-.245	.270	1.000
	post-test after load	-12.135*	.610	.000
	Test after 3 minutes of intervention	-9.141*	.359	.000
	Test after 6 minutes of intervention	-5.779*	.333	.000
Based on estimated marginal means				
*. The mean difference is significant at the. 05 level.				
b. Adjustment for multiple comparisons: Bonferroni.				

From table no. 6 it can be concluded that there was overall significant difference was obtained for selected time intervals. As all the values obtained for pairwise comparison were less than 0.05 (p<0.05) except for one. Lactic acid at different intervals don't have significant difference among them as mean difference between 9 minutes and pre-test was having least significant difference (p-value 1.0, Mean diff. -0.245). The difference between post-test after load and after 9 minute of intervention was having highest significant difference (p-value 0.00, Mean Diff. -12.135).

The difference between post-test 3 minutes and after 9 minute of intervention was having moderate significant difference (p-value 0.00, Mean Diff. -9.141).

The difference between post-test 6 minutes and after 9 minute of intervention was having least significant difference (p-value 0.00, Mean Diff. -5.779). Hence it can be concluded from this table that selected load do increased the lactic acid and lactic acid was decreased to initial state in selected course of time.

Table 7: Pairwise comparison for selected recovery patterns at 3,6- and 9-minutes posttest reading of lactic acid

Test	(I) Intervention given for recovery	(J) Intervention given for recovery	Mean Difference (I-J)	Std. Error	Sig.[b]
Test after 3 minutes of intervention	Active Recovery	Cryotherapy Ice Bath Method	-.098	.580	.868
		Contrast Bath	2.122*	.580	.002
		Passive Recovery	-.160	.580	.786
	Cryotherapy Ice Bath Method	Active Recovery	.098	.580	.868
		Contrast Bath	2.220*	.580	.001
		Passive Recovery	-.062	.580	.916
	Contrast Bath	Active Recovery	-2.122*	.580	.002
		Cryotherapy Ice Bath Method	-2.220*	.580	.001
		Passive Recovery	-2.282*	.580	.001
	Passive Recovery	Active Recovery	.160	.580	.786
		Cryotherapy Ice Bath Method	.062	.580	.916
		Contrast Bath	2.282*	.580	.001
Test after 6 minutes of intervention	Active Recovery	Cryotherapy Ice Bath Method	-1.354*	.629	.047
		Contrast Bath	3.980*	.629	.000
		Passive Recovery	-.600	.629	.355
	Cryotherapy Ice Bath Method	Active Recovery	1.354*	.629	.047
		Contrast Bath	5.334*	.629	.000
		Passive Recovery	.754	.629	.248
	Contrast Bath	Active Recovery	-3.980*	.629	.000
		Cryotherapy Ice Bath Method	-5.334*	.629	.000
		Passive Recovery	-4.580*	.629	.000
	Passive Recovery	Active Recovery	.600	.629	.355
		Cryotherapy Ice Bath Method	-.754	.629	.248

		Contrast Bath	4.580*	.629	.000
Test after 9 minutes of intervention	Active Recovery	Cryotherapy Ice Bath Method	-.780	.686	.272
		Contrast Bath	3.140*	.686	.000
		Passive Recovery	2.820*	.686	.001
	Cryotherapy Ice Bath Method	Active Recovery	.780	.686	.272
		Contrast Bath	3.920*	.686	.000
		Passive Recovery	3.600*	.686	.000
	Contrast Bath	Active Recovery	-3.140*	.686	.000
		Cryotherapy Ice Bath Method	-3.920*	.686	.000
		Passive Recovery	-.320	.686	.647
	Passive Recovery	Active Recovery	-2.820*	.686	.001
		Cryotherapy Ice Bath Method	-3.600*	.686	.000
		Contrast Bath	.320	.686	.647
Based on estimated marginal means					
*. The mean difference is significant at the. 05 level.					
b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).					

In the table above i.e., 7 recovery methods were compared at selected time intervals of interval i.e., 3rd, 6th and 9th minute. Results of pairwise comparison of selected recovery methodologies at Test after 3 minutes of intervention have significant difference between contrast bath therapy and active recovery, passive and cryotherapy as obtained p- value was less than 0.05 (p<0.05 Mean diff. 2.12, 2.20 & 2.82) Results of pairwise comparison of selected recovery methodologies at Test after 6 minutes of intervention have significant difference between contrast bath therapy and active recovery, passive and cryotherapy as obtained p- value was less than 0.05 (p<0.05 Mean diff. 3.98, 5.33 & 4.58) Results of pairwise comparison of selected recovery methodologies at Test after 9 minutes of intervention have significant difference between contrast bath therapy and active recovery and cryotherapy as obtained p- value was less than 0.05 (p<0.05 Mean diff. 3.14 & 3.92).

Discussion on findings

Blood lactate was chosen to be one of the physiological indicators of recovery because it is proposed that the concentration of intramyocellular lactic acid can cause a variety of detrimental electrochemical influences on excitation concentration coupling and metabolic function. (Favero, T. G., Anthony C. Zable, & Colter, 1997; Mengual, R., Abida, K. e., Mouaffak, N., & Rieu, 2003; Pedersen, T. H., Ole, N. B., Graham, L. D., & Stephenson, 2004) [2, 5, 8] According to the findings of the present investigation, the contrast bath therapy after 3rd and 6th minute, was the most effective treatment for lowering lactic acid levels followed by active recovery and cryotherapy. It was also postulated that the large changes in skin temperature brought on by the hot and cold contrast packs were responsible for vasoconstriction and vasodilation, which led to the initiation of a subcutaneous response and mechanical shunting. (Myrer, J. W., Measom, G., Durrant, E., & Fellingham, 1997) [7] Because contrast bath speeds up recovery by increasing the peripheral circulation by removing metabolic wastes and stimulating the central nervous system, contrast hot–cold water technique was considered to be superior to active, passive, and cryotherapy. Additionally, claims that contrast hot–cold increases lactate clearance, reduces post-exercise oedema, and enhances blood flow to fatigued muscle were made. (Moncrieff, 2013) [6].

Conclusion

This study discovered significant effect of different recovery methods on lactic acid. According to the findings of the present investigation, the most effective treatment for lowering lactic acid levels was the contrast bath therapy administered after the third and sixth minute. This was followed by active recovery and cryotherapy as the next most effective treatments. The findings of this study suggested coaches should organise contrast bath therapy sessions for better recovery of medium fast bowlers.

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