

The Effect of Choral Music on Emotions, Immune Parameters and Lung Function during Physiotherapy Treatment of Pneumonia and Bronchitis

ABSTRACT: Introduction: Music, processed by the brain, has a strong impact on the emotions and health. The Magnificat in D major of JS Bach communicates not only a positive emotion of happiness but also motivational behaviour. Infectious lung conditions are often associated with negative emotions which develop due to physiological changes. The hormonal action of the hypothalamus-pituitary-adrenal axes (HPA) could be negatively affected by emotions of anger and depression. This will result in a disturbance of the mind-body interaction. Music therefore can exert a powerful influence on therapeutic benefits by changing the psychological status and the immune endocrine functions.

The purpose of this study was to determine the effect of music, during respiratory physiotherapy treatment on a) the emotional status, b) neuroendocrine responses, c) immune functions and d) lung functions of subjects with infected lung conditions.

Method and Materials: Forty subjects attending physiotherapy treatment was selected according to set criteria and randomly assigned to an experimental and control group. The parameters (Profile Of Mood State [POMS]; CD4:CD8 cell ratios; Cortisol; the Cortisol: DHEA ratio; PF; FEV1; FVC and FEV1/FVC %) were measured on day 1 before the treatment and on day 3 after the treatment. Data were analysed with Statistica (Statsoft) using the Repeated ANOVA tests.

Results: Results indicated that the intervention of music had a positive effect on the immunological parameter (CD4+:CD8+ cell ratios) and on the cortisol and cortisol:DHEA ratio levels. At the same time the psychological status as measured by Profile of Mood States (POMS scale) improved with a significant improvement in the lung functions.

Conclusion: The research provided sufficient scientific evidence that music affects both the biomedical and psychosomatic aspects of infectious lung conditions.

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INTRODUCTION

Substantial research has led to a revolutionary transformation in the way the relationship is viewed between the mind and health and the mind and illness (Grol, 2001; Shine, 2002). It is now clear that negative emotions, will be primarily physiologically induced with infectious conditions that can lead to alterations in neurohormonal activity (Linn et al, 1984, and Cohen, 2000).

This implies that mood disturbances - seen during inflammatory and infectious conditions may partially result from the production of pro-inflammatory cytokines (Viljoen et al, 2003). Negative emotions, such as depression, anxiety and anger could directly influence the cells of the immune systems and hormonal levels (McCraty, 1999; Kiecolt-Glaser et al, 2002). Cortisol increases with stress (Kiecolt-Glaser et al, 1984), and decreases as a result of a positive emotion (Berk et al, 1989; Gunner, 1991). Suppressed negative emotions may block network pathways and stop the flow of biochemicals that run both our biology and our behaviour and are linked to the progression of an illness (Pert, 1997).

The negative influence of psychological variables on the immune system

suggests the possibility that it may also be manipulated in a positive way. Music, which is an emotional communicator that could offer a positive emotional experience, has the ability to bypass the conscious mind and directly access the subconscious mind (Legge, 1999). Music is firstly processed by the brain - (Thaut, 2003), which is also the body's first line of defence against illness (Azar, 2001).

Research shows that music intervention is able to change mood, reduce anger/hostility and disorders, such as fear, depression and stress, and improve energy levels (Magee and Davidson, 2002; Spintge and Droh, 1992; Brennan and Charnetski, 2000; Hargreaves and North 1999). Other studies have demonstrated the immuno-enhancement of

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cell-mediated (Rider and Achterberg, 1990) and humoral immunity (Rider and Weldin, 1990) via the use of immune system imagery accompanied by background music, and that, combining music with other psychosomatic interventions indicates a decrease of cortisol levels and an increase of interleukin-1 (Bartlett, Kaufman and Smeltekop, 1993). A study by Hirokawa and Ohira (2003) reported that music altered the mood of stressed subjects, but with no changes of the immune parameters.

The aim of respiratory physiotherapy treatment as stated by Bott and Moran (1995) is - to reduce fear and anxiety, breathlessness; to improve the efficiency of ventilation; mobilise and aid expectoration of secretions; management of pathology; as well as knowledge to improve exercise tolerance. Batt (2000) stated that reduction of fear and anxiety may be achieved with the normal physiotherapeutic skills of compassion and caring. The acoustic stimuli has been used successfully in physiotherapy to reduce pain (Le Roux, 1999) to create a positive experience between the physiotherapist and paediatric patients with cystic fibrosis (Grasso et al, 1999) and to improve healthy interrelationship between physiotherapist and patient (Booker et al 1985).

The purpose of this study was to investigate the effect of music on selective parameters, while the patients were receiving physiotherapeutic treatment for pneumonia and bronchitis. The hypotheses for this study were a) music would effect the emotions, immune and endocrine systems, b) there would be a relation between the psychosomatic and biomedical changes and c) there would be a significantly positive change of emotions in the experimental group in comparison with the control group.

METHODS

Forty subjects (n = 40) with pneumonia or acute bronchitis, diagnosed by general practitioners, were randomly selected to participate in this study. Randomisation was carried by means of sealed envelopes: each patient was requested to choose an envelope and upon unsealing, was assigned to the group as indicated. All the subjects were recruited from a private physiotherapy

practice (Fish Hoek, South Africa) after referral from a general practitioner for treatment. The research was approved by the Human Research Committee of Stellenbosch University. The subjects falling within the age range of 35-75 years signed a consent form to indicate their willingness to participate in the study. Each patient was coded and all samples were blinded to the laboratory personnel conducting the assays.

The following subjects were excluded from the study:

1. HIV positive subjects.
2. All subjects who presented with secondary lung pathology, as diagnosed by general practitioners.
3. Subjects using immune modulated drugs like Moducare or cortisone.

PROCEDURE

Subjects had objective and subjective evaluation of the respiratory system on the first day. The information obtained was reviewed in order to select participants according to the inclusion criteria. The subjects were asked to complete the Profile of Mood States (POMS-scale). After completion approximately 15cc blood was drawn by a registered nurse appointed by the local pathological services. This blood sample was transported to the laboratory at Tygerberg Hospital for analysis under supervision of a microbiologist. The following tests were conducted: Cortisol levels (RIA, Amerhsam), the Cortisol: DHEA ratio and CD4: CD8 cell ratios (by flow cytometry).

For the lung function determination, the subjects were asked to undertake forced expiration into a calibrated ventilometer while standing. The subjects received respiratory physiotherapy treatment which included nebulising with atrovent/saline solution, percussions, breathing exercises and active coughing.

The music intervention for the subjects who were randomly assigned to the experimental group consisted of the volunteers listening to the Magnificat in D major BWV243 of J.S. Bach for the duration of treatment, which was restricted to 30 minutes. The control group received only the standard physiotherapy treatment for the same duration of time. The treatment was repeated for three consecutive days and at the end

of the third treatment, the measuring procedure was repeated.

Instruments and outcome measures

The POMS scale consists of 65 items in a self-report inventory of adjectives that describes different positive and negative emotional states. Subjects rate each item on a 5-point scale from 0 (not at all) to 4 (extremely). Scoring potentially results in scores for each of six discrete affective states: Tension/Anxiety; Depression/Dejection; Depression/Dejection; Anger/Hostility; Vigour/Activity; Fatigue/Inertia and Confusion/Bewilderment. The POMS was selected because it has been standardised for a non-psychiatric population (McNair et al, 1981).

Whole blood samples (EDTA-anti-coagulated) were processed within 6 hours of blood drawn. Briefly, 100uL blood was mixed with an 20uL aliquot of a mixture of monoclonal antibodies purchased from Becton Dickson (SA Scientific, Cape Town). The tubes containing the blood and monoclonal antibody mixture were incubated at room temperature for 15 minutes in the dark and thereafter 450uL of a lysing buffer (FACS lysing buffer, Becton Dickinson, SA Scientific, Cape Town) was added to each tube. The tubes were incubated in the dark for a further 10 minutes at room temperature and subsequently analysed on a flow cytometer (FACS Calibur, Becton Dickson, SA Scientific, Cape Town).

The adrenal cortisol and dihydroepiandrosterone sulphate (DHEAs) were measured in clotted blood samples collected at the same time as those above. The samples were centrifuged and the serum stored at -20°C until assayed. The two hormones were assayed with radio-immune assays (Amersham, Cape Town). The results were expressed as individual hormones (DHEAs in umol/L and cortisol in nmol/L or as the ratio between the cortisol:DHEAs levels in order to normalize the individual variations. All assays were conducted on the frozen sera in order to minimise batch to batch variation in the measurements.

The measurement of the lung functions were performed by a calibrated ventilometer (Clement Clark; Kat no 310 8001 Reg Des no 1060400 Patent

GB 2238130 UK). The peak flow (PF), forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) and the % of FEV1 / FVC were measured by a registered physiotherapist, the highest values were taken from three satisfactory attempts.

RESULTS

Comparison of the parameters of the two groups at baseline indicated that the groups were balanced and that no statistical differences existed prior to the intervention and assays for the diverse biological markers. Nine (9) men and 31 females were included in the study. (See Table 1, Demographics of groups at baseline).

Hormonal and immune changes

Our results show that the experimental group had reduced their serum cortisol levels on the third day, (368 vs. 336) whereas the same parameter had increased in the control group during the same period (409 vs. 447). The difference between the experimental and control group was statistically significant ($p < 0.001$). Cortisol is known to have immune suppressive activity on the functioning of the white blood cells and since these results indicate that the intervention with music lead to a drop of this hormone in the experimental group, it implies that after music intervention and physiotherapy treatment, this group would have improved more dramatically when compared to the control group.

Other parameters which substantiate the above observation include the results of the cortisol: DHEA ratio: in the experimental group, this ratio was significantly reduced by day 3 whereas in the control group, this ratio had increased. The difference was also statistically significant ($p = 0.04$). Again, the increase in the Cortisol: DHEA ratio (as observed in the control group) implies either an increase in the Cortisol or a decrease in the DHEA level or both. This indirectly indicates a greater immune suppressed state of the patient since DHEA counter-regulates the immune suppressive activity of Cortisol.

Furthermore, the immune parameter of CD4: CD8 cell ratios reveal a significant difference among the experimental group on the third treatment day

(2.07 ± 0.95 vs. 2.25 ± 1.17 , $p = 0.045$) whereas the ratio in the control group had declined over the same period of time 2.18 ± 1.46 vs. 2.06 ± 1.46 . Again, the difference between groups was statistically significant ($p < 0.001$). Once again, an increase in the ratio

between the CD4 and CD8 cells implies a less suppressed state and this is clinically relevant to the outcome of an infective state.

Emotions

(See Figure 1).

TABLE 1: DEMOGRAPHICS OF GROUPS AT BASELINE.

Table 1.1: Demographics of subjects that participate in study group.

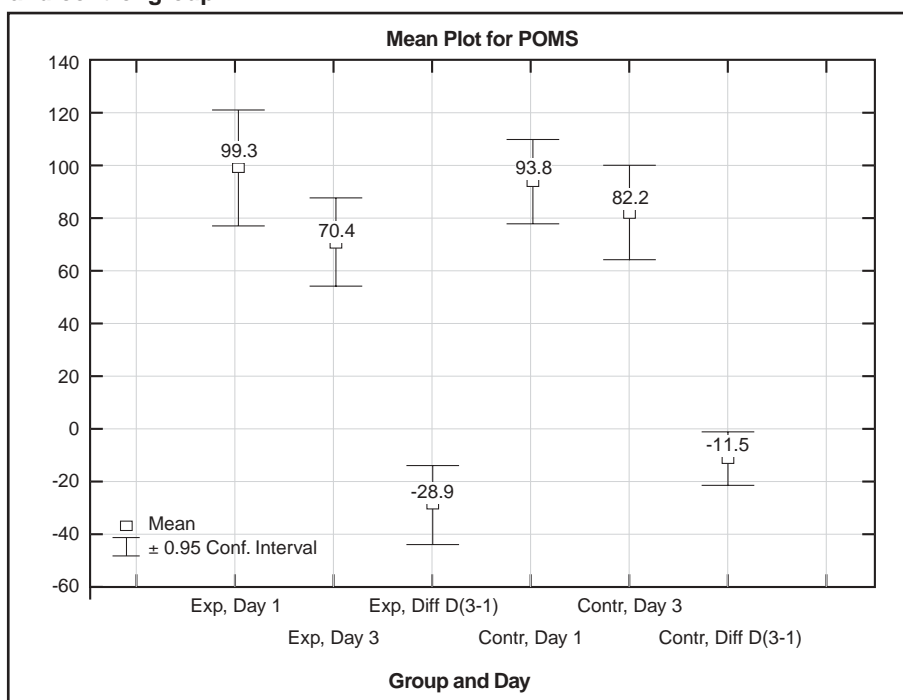
	Male	Female	Ave Age	Age spectrum
Experimental	4	16	60	40-70
Control	5	15	65	43-75

Table 1.2: Comparison of parameters between experimental and control groups day one before intervention.

Parameter Day 1	Experimental Gr Day 1	Control Group	Significant
Cortisol	368.1 +/- 134.17	409.55 +/- 156.3	NS
Cort: DHEA ratio	295.17 +/- 195.75	356.26 +/- 225.51	NS
Average POMS	99.30 +/- 46.98	93.75 +/- 33.93	NS
FVC	2.15 +/- 0.79	2.22 +/- 1.05	NS
FEV1	1.60 +/- 0.84	1.70 +/- 0.87	NS
FVC/FEV1	0.73 +/- 0.25	0.74 +/- 0.20	NS
PF	316 +/- 91.79	303.16 +/- 146.12	NS
CD4+:CD8+ ratio	2.07 +/- 0.95	2.18 +/- 1.46	NS

NS = not significant

Figure 1: The parameters of the POMS subscale comparing the experimental and control group.



The subscale of depression and anger showed no significant changes in the control group, but significant changes in the experimental group regarding depression ($p = 0.001$) and anger ($p = 0.007$). In Figure 1 the composite parameters of the POMS scale are represented: it can be seen that although both groups showed an improvement in the general POMS composite value, the change was greater for the experimental group when compared to that of the control group.

The experimental group showed the most dramatic changes in the psychological parameters measured individually (Dep, Ten, etc) as well as collectively (total score) expressed as the composite POMS score. This is evident when one compares the parameters for the control group (Table 2) to those measured in the experimental group (Table 3).

Lung Functions

The ventilometer parameters measured showed the most dramatic positive changes in the experimental group. Indeed, as shown in Table 4, the peak flow of these patients reveal a dramatic increase of 70 litres (316 ± 91.8 day 1 vs. 382.4 ± 68.3 day 3; $p = 0.0001$). In the control group, this change was less dramatic although the patients did show an improvement (303 ± 146.1 day 1 vs. 308.6 ± 154.4 day 3, NS). The change in this parameter between groups was statistically significant ($p < 0.006$).

DISCUSSION

During an infective illness, negative emotions are induced, which could be ascribed both to physiological (due to biochemical changes) and psychological changes (Knapp, 1992; De Rijk et al, 1997).

The tension/anxiety subscale of the POMS scale in both the experimental and control group were significantly improved. However, when one compares the differences between groups, it appears that the intervention with music adds substantial value to physiotherapy: the control group registered no significant changes in the subscale of anger/hostility and depression while the experimental group indicated significant differences in both the anger/hostility subscale ($p = 0.007$) and depression subscale ($p = 0.001$) despite

these parameters being similar (not statistically significant) at baseline. Depression has often been interpreted as suppressed anger (Pert, 1997). It is feasible that the negative suppressed emotion of the control group also resulted into a higher level of cortisol by day 3, whereas the experimental group ($p = 0.009$) had significantly lowered their cortisol level. Although short-term decreases in cortisol following periods

of listening to music have been observed in healthy individuals (Bartlett, Kaufman and Smeltekop, 1993) and listening to music has been shown to buffer the cortisol increase experienced by patients undergoing surgery with epidural anaesthesia (Tanoika et al, 1985), no research has as yet been undertaken on infected diseases with related negative emotions. Previous studies also indicate a relationship between a decrease of tension

Table 2: Changes in various sub-parameters of the POMS scale in the control group over a period of 3 days (baseline versus day 3).

Sub-Parameter	Day 1 Baseline	Day 3 After intervention	Significance ($p = 0.05$)
TEN	20.55 +/- 7.51	17.4 +/- 9.01	0.04
DEP	23.25 +/- 9.57	20.45 +/- 11.36	NS
ANG	18.3 +/- 12.05	16.2 +/- 11.20	NS
CON	15.1 +/- 5.86	13.4 +/- 6.13	0.03
FAT	17.15 +/- 8.51	15 +/- 6.81	0.04
VIG	-19.9 +/- 8.26	-21.6 +/- 7.71	0.03
Total POMS scale	93.75 +/- 33.93	82.20 +/- 38.14	0.03

NS = not significant

Table 3: Changes in various sub-parameters of the POMS scale in the experimental group over a period of 3 days (baseline versus day 3).

Sub-Parameter	Day 1 Baseline	Day 3 After intervention	Significance ($p = 0.05$)
TEN	21.45 +/- 8.86	15.3 +/- 7.95	0.0004
DEP	25.76 +/- 15.0	17.5 +/- 9.60	0.001
ANG	16.9 +/- 11.63	11.75 +/- 6.36	0.007
CON	15.6 +/- 7.7	12.7 +/- 7.07	0.006
FAT	19.65 +/- 9.70	13.25 +/- 8.58	0.00001
VIG	-17.3 +/- 7.02	-21.15 +/- 5.49	0.0002
Total POMS scale	99.30 +/- 46.98	70.35 +/- 36.19	0.0003

NS = not significant

Table 4: Changes in the ventilometric measurement in the experimental group over the 3 day period of study.

Parameter	Day 1 Baseline	Day 3 After intervention	Significance ($p = 0.05$)
FVC	2.15 +/- 0.79	2.22 +/- 0.75	NS
FEV1	1.60 +/- 0.84	1.89 +/- 0.68	NS
FVC/FEV1	0.73 +/- 0.25	0.81 +/- 0.19	NS
PF	316 +/- 91.79	382.25 +/- 68.33	0.00001

NS = not significant

(relaxation) and a decrease of cortisol among hypertension and diabetic persons (Surwit and Feinglos, 1984). A previous study by McCraty (1999) reveals a relation between increased anger and cortisol: DHEAs ratio. The latter correlates with this researcher's findings relating to the significant decrease of the subscale anger and the cortisol: DHEA's ratio ($p = 0.04$). These findings indicate that the hormonal action of the hypothalamus-pituitary-adrenal axis (HPA) could be negatively affected by suppressed emotion.

The hypothalamus, is the area involved in the processing of music and emotions (Roederer, 1985). The music stimuli would first reach the thalamus, which is connected to the amygdala, the process area of negative emotions. If all negative emotions are not strongly expressed, these will create a blockage of the neuropeptides flow. Previous research indicates that the immune system would improve upon an increase of CD4 cells if negative emotions are expressed (Petrie et al, 1998). The amygdala also links with the nucleus accumbens, the centre of positive emotions and it would develop an inhibitory effect on the amygdala (Le Doux, 2000). This again would affect the HPA-axis and lower the cortisol levels and improve the immune system (Taylor, 1999). In this study the experimental group on the third treatment day showed a significant improvement of the CD4 : CD8 cell ratio ($p = 0.045$) which indicates an improved immune system.

The physiological results also indicated a significant improvement of the peak flow measurement of the experimental group ($p = 0.04$). When the experimental and control group were compared, the experimental group indicated again a statistically significant difference ($p = 0.001$). Again, statistical evaluation of the groups at baseline indicated no differences in the groups therefore this change cannot be attributed to the baseline differences. Peak flow changes have been measured during psychosocial intervention of laughter and guided self-management of asthma patients, but no psychological intervention was reported during any other physiotherapy treatment (Wensley and Silverman, 2004; Liangas et al, 2003).

This indicates that our emotions, immune and nervous system conceptually form an indivisible whole, and this also demonstrates communication between the body, mind and emotions. The findings of the research provide sufficient substantiation to conclude that immune modulation through specific functional music is able to provide a positive emotional action and better lung function. The research data confirm the healing value of music within both the psychosocial and biomedical aspects of the infectious lung conditions.

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