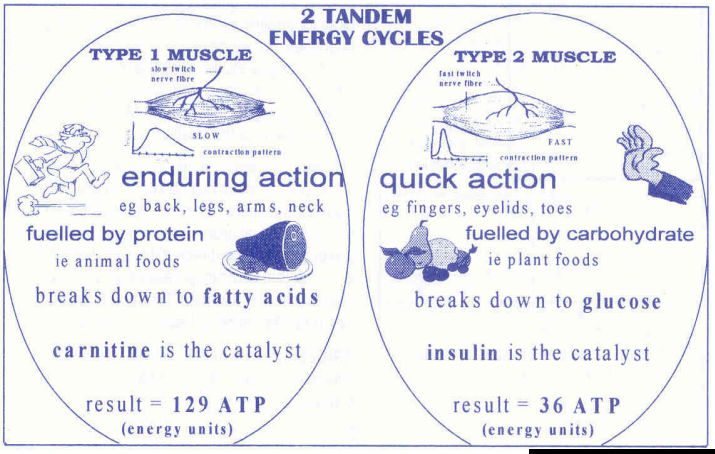
Carnitine – how it really works!

by Tessa Jupp RN - Polio Clinic WA

I was asked to the recent International Polio Conference to speak about our carnitine research here in WA. I have been meaning to simplify for the newsletter, what we have learnt since we started looking at blood levels of carnitine back in 1996 - so here's 12-years worth of our carnitine journey. We couldn't have done it without all of you - our members who have gone and had those blood tests done!

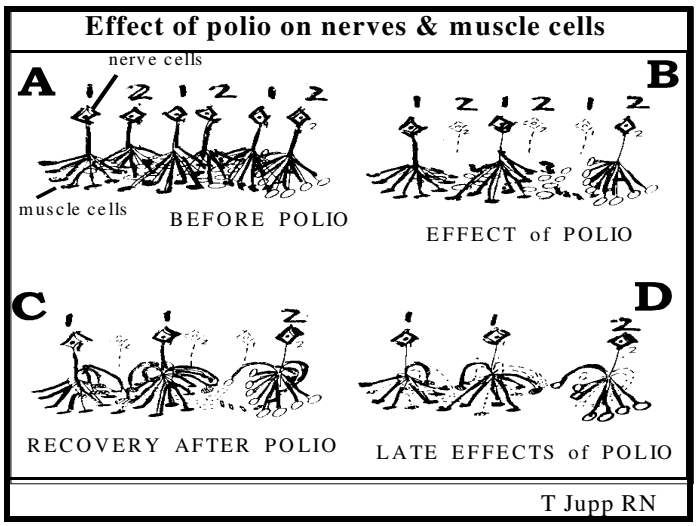
Carnitine is an amino acid ie part of protein, and is found in our diet primarily in red meat. Avocado is the only reasonable plant source. The redder the meat the better - pork has only half and chicken only one tenth of the carnitine in red meat! We should get 75% of our needs from our diet and our bodies can make 25% - ***but only if*** the other nutrients needed are present in the body and you have muscles to store it!

Carnitine transports protein fats into the cell so they can be broken down to produce energy to run the body. More energy is produced this way than using carbohydrate foods. Insulin is needed for energy from blood glucose - carbohydrate foods (yield is 36 ATP) but carnitine is needed to get energy from protein fat (energy yield this way is 129 ATP ie longer energy).



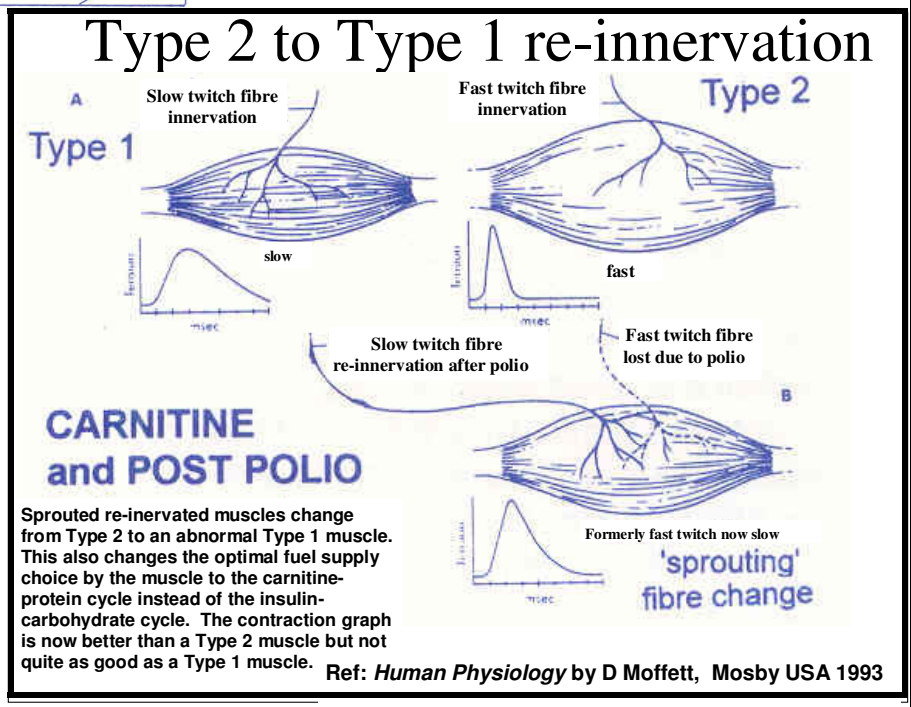
We have 2 types of muscles - Type 1 muscles use protein fats as fuel and Type 2 muscles use glucose. There are corresponding nerve types that make these muscles work. Swedish polio research by Borg & Grimby in *Post Polio Syndrome by Halsteadi & Grimby Mosby USA 1995* showed that in muscle biopsies on polio muscle there were more Type 1 muscles and that some were abnormal Type 1 that were not as efficient.

This correlates with research documented in *Human Physiology by D Moffett Mosby USA 1993* where switching of nerve type changes muscle type and fuel needed. This is in line with the accepted theory of *"sprouting"* of remaining nerve endings to enable recovery of muscles affected by polio at the time of acute polio.



In the diagram above, nerves of each type may be affected by polio, recovery after polio due to re-sprouting (possibly more type 1 nerves survive) and further loss is occurring now as overworked nerves and muscles lose the extra sprouting.

If we can maintain good levels of all the nutrients needed for these stressed nerves and muscles to keep working, we can slow down the rate of deterioration. When polios *"hit the wall"*, we have used all the available energy near those muscles and they stop working temporarily. When we rest, the body recruits more carnitine from elsewhere that is not depleted to get more energy into the cell again. If we can maintain high levels of carnitine in the blood on a daily basis (lost muscle due to polio means lost storage capacity in muscles) then we can top up quicker and so keep going longer without stressing struggling nerve and muscle cells. Other nutrients like magnesium, manganese, potassium, protein foods etc need to be replenished as well.



Normally 20% of our muscles are working at any given time and 80% are on rest and recuperation. In polios we no longer have 100% of our muscles so time between shifts is reduced. If we don't have any more workers, we must feed those left more quickly to get them back on shift again. Having more carnitine available in the blood achieves this.

Of 100% of muscles in normal people, at any time – only 20% are needed to operate a muscle group

ie 4 rest while 1 works

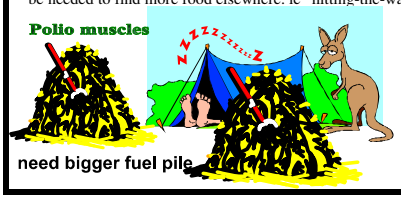
but if 60% muscle lost due to polio & aging, so now only 40% is left, then they have to work "1 on & 1 off" basis

Polio muscles

If we translate that concept to blood level readings, the given *"normal range"* does not apply for polios. Blood result forms tell us that normal carnitine range is:

- So to keep on working, food supply for muscles will need to be abundant and close at hand. As carnitine is the catalyst for energy production for endurance type 1 muscles, in people with varying muscle loss, higher blood levels are needed to keep those muscles working or more time off will be needed to find more food elsewhere. ie "hitting-the-wall"

Polio muscles



need bigger fuel pile

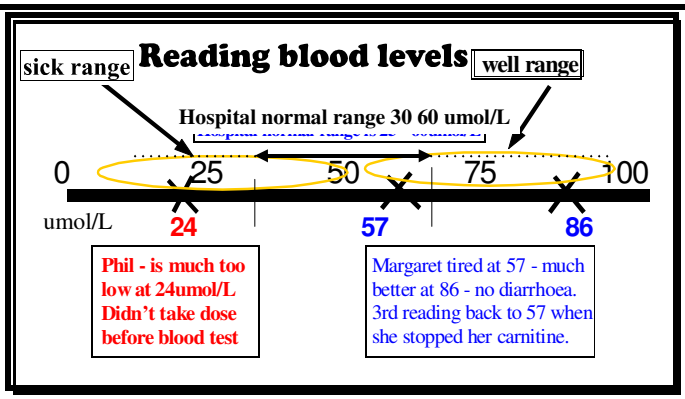
Free carnitine	**30 - 60 umol/L**
Total carnitine	**35 - 65 umol/L**

Acyl-carnitine is total minus free and equals what has been used. Acyl divided by total as a percent show how much has been used out of what was available. Good usage is between 10% - 25%. If we use more than 25% without good top-up, we would obviously get to critical levels within a few days which could be dangerous, particularly as heart muscle also needs carnitine to keep it pumping. So we slow down.

Each one of has our own individual levels that will be right for us. That is why we want everyone that is tired to get carnitine levels done before starting carnitine and again a month or so later when they feel good to show the level each of us needs to be at to be okay. I feel great when mine is 76 umol/L.

From our records, I used the example of Margaret who was tired at 57 (doctors would have said that was a good level) but taking carnitine to the dose that she feels much better at, her levels come in at 86 with no sign of overdose ie no diarrhoea.

Phil's reading was very interesting because he didn't take his morning carnitine dose before his blood test as he was in a hurry - it came in at 24! So what we actually recorded was how low his levels get overnight before he tops up for a day's work. No wonder he needs to take a carnitine supplement!

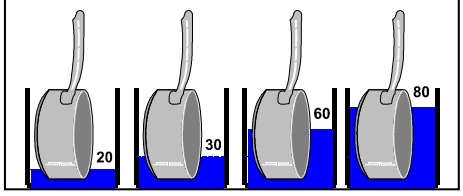


	Margaret's results		Phil's results
	14/9/06	23/10/06	19/1/07
free carnitine	57	86	24
total carnitine	62	97	26
acyl-carnitine	5	11	2
acyl/total %	8%	11%	7%

So the higher the acyl-carnitine reading the more has been able to be used. The lower the acyl the less energy available. If you think of it as how much water can you get into a saucepan to empty from a bucket to water say a pot plant - the better off the pot plant will be and the quicker it is replenished. If there is only a small amount to take from - like Phil with 24 - he can only get 2 out - no wonder he was fatigued! We are still waiting for his next blood test results.

Serum carnitine is like saucepans in a bucket

- The fuller the bucket, the more you can get into the saucepan. If the bucket is nearly empty you only get a trickle. If it is too full it will overflow (diarrhoea).



So far we have had 1320 results over 12 years from 901 people. 527 polio people, 284 descendants of polios, 90 CFS etc. All were tired & have low levels.

Below is a sample of the graphs we can make from your results. A lot of people neglect going back for their second test, but it can show if you have it right and tells us and you what level is ***"your normal"*** to feel okay. Just ring me for a path slip to get it done.