UTILISATION OF BLOOD LEAD LEVELS

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Blood lead levels were utilised for several reasons:

- In many birds metal fragments do not show up on radiographs. This is especially the case in smaller birds;
- Many owners did not find the source of the lead poisoning until the blood lead results were presented to them. In cases where owners were renovating, both the problems of no fragments on the radiographs and owners' disbelief that the renovations were unsafe necessitated blood lead measurement;
- Radiographs may have radiodense fragments that may not be lead or, in cases of semi-radiopaque fragments, the lead results confirm the exposure to lead

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Importance of differentiating the various types of heavy metal poisoning

Often the theory has been that the treatment is the same for all types of heavy metal poisoning and therefore finding the type of metal is unimportant. However it is very important to differentiate lead from zinc and copper poisoning as lead, unlike the other two, is **not a normal finding at any level in animals as it is not used by any biochemical pathway.** So any amount of lead above a minute quantity suggests exposure above normal air pollution levels and the source needs to be identified. Also, unlike the other two heavy metals, lead accumulates in the body and, as it is not utilised, will build up over years with further exposure. This also affects the treatment regime as treating the clinical signs does not necessarily remove the subclinical problems or prevent the build up of lead in the future.

There is also the problem of the public health risk of high lead levels in the owners' environment. This is unlikely to be the case with either zinc or copper poisoning. This is a problem in the inner suburbs of Sydney with the renovation of many old houses and the soil of many homes having high lead levels.

Problems associated with blood lead testing

Lead is quickly absorbed from the blood into the soft tissues beginning with the liver and then into the bone. If there was a short exposure to lead in the distant past it may not be reflected in the blood lead results. The most accurate diagnostic method for lead exposure is measuring lead levels in the liver.

High blood lead levels are not an accurate picture of whether the clinical signs the bird is presented with are caused by the lead. In humans, other tests are performed to test the clinical affects of lead toxicity on haemoglobin.

Therefore a low reading does not mean the bird has not been exposed in the past and a high reading does not in every case mean the bird's clinical signs are explained by lead poisoning. A low constant source of lead or a high recent dose will be reflected in the blood lead levels.

Other common non-specific tests utilised for the diagnosis of heavy metal poisoning

Radiographs without blood lead level testing may indicate large pieces of lead. It has also been suggested enlarged kidneys may be seen as a radiographic change. Many birds are radiographed and treated for heavy metal poisoning without blood lead tests to accurately determine if lead was involved.

Previous studies have anecdotally suggested that uric acid is often increased in cases of lead poisoning. This was not found in any of the cases in which biochemistry was performed.

Previous reports also anecdotally suggested that a gram stain of the faeces would have a low number of bacteria compared to the crop (in normal circumstances the reverse is generally true). These reports were not consistently supported in the birds that tested positive for higher than normal blood lead levels.

Blood lead levels were collected for three reasons in this study. To investigate:

- exposure to lead;
- clinical signs commonly associated with lead poisoning;
- self-mutilation

Other tests performed depended on the clients' wishes and responses to treatment. These included radiographs, Clearview chlamydia tests and biochemistry.

All birds had a crop and faecal smear and most had a gram stain performed.

Methodology

Blood was collected from the jugular and placed in a lithium heparin tube. The minimum volume of blood required in lithium heparin is 0.2ml. If the sample clotted or was taken in a plain tube the laboratory requested 0.5ml of blood.

The small sample volume allows testing on even the smallest birds.

Samples were sent to the Veterinary Pathology Service.

Legend for all tables

#Same Galah, ~same Princess Parrot, *same Galah

Cals/poly/oral = Calsenate injections 40mg/kg intramuscularly (sodium calciumEDTA) for 4-5 days, oral polyaid Metamucil, Psittavet injection then 10 days oral Calsenate double dose

Baytril= enrofloxacin; Psittavet = doxycycline for 45 days;

Clomicalm = clomipramine; Ronnivet = ronidazole;

Clavulox = amoxycillen/clavulanic acid

Cals inj = Calsenate injection 40mg/kg intramuscularly (sodium calciumEDTA)

Table 1 - Blood Lead Levels

Lead mmol/L	*Species*	*Clinical signs*	*Skin*	*X-ray*	*Treatment*	*Responded to treatment*	*Retest*
4.50	Macaw	feather loss	yes	no	cals/poly/oral	yes- initially improved lost to follow up	no
3.56	Lorikeet	ataxia	no	no	cals/poly/oral	yes- (owner stopped painting)	no
3.00	Galah	mutilation	yes	yes	cals/poly/oral	yes	no
2.90	Princess ~	ataxia	no	no	cals/poly/oral	no	1.07
2.40	Budgie	leg paralysis	no	no	cals inj bid 4d then oral 8d	no- no change to leg/demeanour improved	no
2.15	Galah #	unwell/feet chewing	yes	yes	cals inj sid 3d then oral 6d	no- change so .06/1w/2w rexray small frags 1/1/4	1.8
1.80	Galah #	retest post treatment	yes	no	cals/poly/oral	yes	.51
1.71	Galah *	unwell/polyuria	no	no	cals/poly/oral	yes- but blood leads still high so use weekly inj	1.51
1.50	Galah *	retest post treatment	no	no	cals inj 1/week for 4weeks	yes- but blood leads still high	no
1.33	Eclectus	unwell	no	no	cals/poly/oral	yes	no
1.32	Budgie	head tilt	no	no	cals inj sid 4d then oral 8d	yes	no
1.27	Lorikeet	polyuria	no	no	cals inj 1/week for 4weeks	yes	no
1.24	Scc	vomiting/mutilation	yes	yes	cals/poly/oral	yes- too early to see if skin better	no
1.22	Lorikeet	polyuria	yes	no	cals/poly/oral	yes	no
1.18	Conure	polyuria	no	no	1cals inj change diet	yes- more signs and removed from exposure	no
1.10	Cockatiel	poor flier/mild mutilation	yes	no	no	yes- on Ronnivet	no
1.07	Princess ~	retest post treatment	no	no	cals inj 1/week for 4weeks	yes- 1 month after treatment	no
1.06	Scc	retest/previous injections	no	no	cals/poly/oral	yes- after second treatment(first from other vet)	no
1.05	Budgie	ataxia	no	yes	cals inj bid 2days	no- died large spleen/liver/kidney on PM	no
0.85	Galah	polyuria	no	no	Baytril Psittavet	yes- diabetic (diet changed)	no
0.83	Eclectus	post treatment test/ate bell	no	yes	cals/poly/oral	yes	is retest
0.68	Budgie	seizures/hypocalc. on bloods	no	no	calcium oral/Baytril oral	no- improved on phenobarbitone (biochem neg)	no
0.51	Galah #	retest 2nd retest	no	no	no	yes	no
0.48	Galah *	retest 2nd retest	no	no	no	yes	no
0.46	Cockatiel	aggressive/eats mirror	no	no	no	yes- change behaviour	no
0.43	Budgie	unilateral leg paralysis	no	yes	VitA/Baytril/diet change	no	no
0.43	Budgie	mutilation	yes	no	cals inj bid 2days	yes- on Psittavet	no
0.35	Budgie	very ill/green urates	no	no	Baytril/cals/poly	yes- slowly (very rusty cage changed)biochem-liver	no
0.31	Macaw	vomiting	no	no	cals inj sid 2days poly	yes	no
0.20	Cockatiel	ataxic	no	no	no	yes- when new feathers	no
0.16	Princess	ataxia(mild)	no	no	initially cals inj/polyaid	yes- on antibiotics	no
0.13	Ringneck	chewing	yes	no	Baytril/Psittavet (PBFD neg)	yes- initially to behavioural changes/re-mutilated later	no
0.10	Peachface	mutilation	yes	no	Baytril/Psittavet	yes- when owner changed bond to husband	no
0.08	Cockatiel	mutilation	yes	no	Baytril/Psittavet/collar/ronnivet	yes- when on dipenhydramine	no
0.08	Galah/Corella	altered behaviour	yes	no	Baytril/clavulox/clomicalm	yes- on clomicalm/ all tests neg (zinc,biochem,PBFD)	no
0.06	Peachface	mutilation	yes	no	Baytril/Psittavet	yes- when later on clomicalm	no

Results for Table 1

1. Birds responded to Calsenate injections 40mg/kg intramuscularly (sodium calciumEDTA) if the lead levels were above 1.22mmol/L. Previous studies have suggested that blood lead levels above 1.93mmol/L are indicative of lead poisoning. This suggests that any bird with blood lead levels above 1.22mmol/L should be treated for lead poisoning. The source of the lead was discovered in all the birds with blood lead levels above 1.22mmol/L.

2. Levels could be as high as 4.50mmol/L with birds still able to perform most functions adequately.

3. At the higher levels, birds only responded if they had been treated with Calsenate injections and were tube-fed with Polyaid and Metamucil for at least 4 days, then on oral Calsenate for double the time at a double dose.

4. The two galahs that were re-tested had both re-exposed themselves to the lead. This shows the value of retesting.

5. Some birds had extremely low blood levels despite all the birds (except the macaw at 4.50mmol/L) living in the inner city suburbs of Sydney. This does not support the theory that blood leads may be in the high normal range because of environmental pollution from lead exhaust fumes. The lowest figure (0.06mmol/L) was from a peachface living in the same suburb as the major Sydney oil refinery. However the table does not show the ages of the birds so it is still possible that over a period of 10-20 years blood lead levels could increase from car exhaust fumes.

6. Two birds (SCC 1.06mmol/L and princess 1.07mmol/L) whose blood lead levels were still between 1.00 and 1.10mmol/L responded to further treatment for heavy metal poisoning. This suggests that if the post treatment level is above 1.00mmol/L then further treatment and investigations into exposure should be carried out.

Table 2 - Lead and Self-Mutilation

Species	Lead	Clinical signs	Treatment	Responded to Treatment
Macaw	4.50	feather loss	cals/poly/oral	yes- initially improved lost to follow up
Galah	3.00	mutilation	cals/poly/oral	yes
Galah #	2.15	unwell/feet chewing	cals inj sid 3d then oral 6d	yes after change to .06/1w/2w
Scc	1.24	vomiting/mutilation	cals/poly/oral	yes- too early to see if skin better
Lorikeet	1.22	polyuria/ mutilation	cals/poly/oral	yes
Cockatiel	1.10	poor flier/mutilation	no	yes- on ronnivet
Budgie	0.43	mutilation	cals inj bid 2days	yes- on Psittavet
Ringneck	0.13	chewing	Baytril Psittavet	yes- initially/ re-mutilated 2 month later
Peachface	0.10	mutilation	Baytril/Psittavet	yes- when owner changed bond to husband
Cockatiel	0.08	mutilation	Baytril/Psittavet/collar/ronnivet	yes- when on dipenhydramine
Galah/Core	0.08	altered behaviour	Baytril/clavulox/clomicalm	yes- when on clomicalm/ all tests neg
Peachface	0.06	mutilation	Baytril/Psittavet	yes- when later on clomicalm

Results for Table 2

1. Five of the twelve self-mutilating birds had blood lead levels over 1.22mmol/L. In most cases the birds which responded best to heavy metal treatment had blood lead levels over 2.15mmol/L.

2. Only one of the five birds with lead levels over 1.22mmol/L had not responded to treatment. This bird was only tested 2 weeks prior to results having being compiled and so it may be too early to conclude if treatment was successful.

Table 3 - Lead and Neurological Signs

Species	Lead	Clinical signs	Treatment	Responded to Treatment
Budgie	1.05	ataxia	cals inj bid 2days	no- died large spleen/liver/kidney on PM
Lorikeet	3.56	ataxia	cals/poly/oral	yes- (owner stopped painting)
Princess~	2.90	ataxia	cals/poly/oral	yes after second treatment as re-exposed
Princess	0.16	ataxia(mild)	initially cals inj/poly	yes- on antibiotics
Cockatiel	0.20	ataxic	no	yes- when new feathers
Budgie	1.32	head tilt	cals inj sid 4d then oral 8d	yes
Budgie	2.40	leg paralysis	cals inj bid 4d then oral 8d	no- no change to leg/demeanour improved
Budgie	0.68	seizures/hypocalcaemia	calcium oral/Baytril oral	no- improved on phenobarbitone biochem neg
Budgie	0.43	unilateral leg paralysis	VitA/Baytril/diet change	no

Results for Table 3

1. Four of the nine birds blood tested for neurological signs which were not related to simple weakness from illness had blood lead levels over 1.22mmol/L.

2. Two of the five birds with ataxia had high blood lead levels. Another bird had above normal exposure (budgie 1.05mmol/L) but died prior to treatment. Both the birds with high blood lead levels responded to treatment after being removed from the source of exposure.

One of the two budgies with leg paralysis had very high blood lead levels. The leg paralysis did not respond to treatment though the bird's demeanour improved.

Table 4 - Radiographic Changes

Species	Lead	Clinical signs	X-ray
Galah	3.00	mutilation	fragments kidney swollen
Galah#	2.15	unwell/feet chewing	radiodense fragments
Eclectus	0.83	post treat test/ate bell	7 days before radiodense fragments
SCC	1.24	vomiting/mutilation	radiodense fragments
Budgie	1.05	ataxia	enlarged liver/kidney
Budgie	0.43	unilateral leg paralysis	no fragments- enlarged kidney

Results for Table 4

1. All the birds with radiopaque fragments in the gizzard had higher than 1.22mmol/L for blood lead levels.

2. The SCC had lower blood leads but had only ingested the material the previous day and so may not have yet absorbed a high level of lead at the point of blood lead collection.

3. The results are not meant to suggest that all radiodense fragments in the gizzard are lead as these three birds were large birds that were seen to ingest lead objects. Many other birds not included in the study had radiopaque fragments in the gizzard but were not blood lead tested.

4. The eclectus had been radiographed and then treated for heavy metal poisoning. At the completion of the treatment it was blood lead tested.

Table 5 - Treated One Calsenate Injection Once Weekly

Species	Lead	Clinical signs	Treatment	Responded to Treatment
Princess	1.07	retest post treatment	cals inj 1/week-4weeks	yes- 1 month after treatment
Galah	1.50	retest post treatment	cals inj 1/week-4weeks	yes- but blood leads still high
Lorikeet	1.27	polyuria	cals inj 1/week-4weeks	yes

Results for Table 5

1. All the birds responded clinically to the once weekly treatment.

2. The only bird re-blood tested one week after the final injection had not shown a significant drop in blood lead levels.

Table 6 - Re-tested Birds

Species	date	Lead	Clinical signs	Treatment	Responded to Treatment
Galah#	28/02/99	2.15	unwell/feet chewing	cals inj sid 3d then oral 6d	no -change so .06/1w/2w
Galah#	10/04/99	1.80	retest post treatment	cals/poly/oral	yes
Galah#	22/05/99	0.51	retest 2nd retest	no	yes
Galah *	14/04/99	1.71	unwell/polyuria	cals/poly/oral	yes- but blood leads still high so use
Galah *	07/05/99	1.50	retest post treatment	cals inj 1/week-4weeks	yes- but blood leads still high
Galah *	29/06/99	0.48	retest 2nd retest	no	yes
Princess~	15/02/99	2.90	ataxia	cals/poly/oral	no
Princess ~	08/03/99	1.07	retest post treatment	cals inj 1/week-4weeks	yes- 1 month after treatment

Results of Table 6

1. Galah # did not respond until on the concentrated treatment (cals/poly/oral).

2. Galah * responded clinically but is suspected to have re-ingested lead between the first and second blood test.

Summary of Results/Discussion

All birds with blood lead levels above 1.22mmol/l were treated as heavy metal poisoning cases. If the blood levels were not lower than 1.00mmol/L post treatment it suggested a failure of the treatment or a re-exposure to lead.

Blood lead levels below 1.22mmol/L responded to other forms of treatment. However this does not rule out the possibility of subclinical increased lead levels in these birds leading to secondary problems.

Birds could have very low blood lead levels despite high environmental exposure to car fumes in the inner city. Theoretically this would be a constant low dose exposure that would be reflected in the blood lead levels. Many of the lowest lead levels were from birds living in houses on main roads, in the inner city and even one next to an oil refinery.

44% of birds that were tested after being presented with a neurological problem had high levels of blood lead. Therefore all birds with neurological signs should be treated or tested for lead poisoning.

42% of birds that were self-mutilating had high levels of blood lead. However, in the case of the self-mutilation a complete response to treatment was inconclusive. In many cases there were other symptoms which responded to treatment. It may be too early to conclude if the self-mutilation was wholly related to heavy metal poisoning. The birds which tested negative for lead, giardia, biochemical abnormalities, PBFD (Psittacine Beak and Feather Disease), chlamydia and did not respond to 45 days of Psittavet and 10 days of Baytril responded initially to 4-6 weeks of Clomipramine.

Treatment with Calsenate injections once weekly for four weeks did alleviate the clinical signs. Only one bird was re-tested post treatment and its blood lead levels were not significantly lowered. This bird had however been re-exposed to the source of the lead. Some success was achieved with once weekly injections. This was used in the cases of poor client compliance or when owners did not wish to leave their birds in hospital for 4-5 days. The best response was to 4-5 days in hospital with Calsenate injections twice daily, Polyaid/Metamucil by tube and then a double dose of Calsenate orally for 10 days ("the complete treatment").

Previously many birds were given the "complete treatment" on suspicion of heavy metal poisoning. The cost of testing compared to blanket treatment suggests that blood testing is preferable.

In some cases, despite the low blood lead results, treatment may still be needed on suspicion of lead poisoning. It may be possible to utilise the "complete treatment" or the alternate approach of a treatment trial of weekly injections.

Post treatment blood lead level testing was found to be very useful in checking for failure of treatment or re-exposure to lead. Client compliance with retesting was low. In most cases the client was satisfied with the initial response to treatment.

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