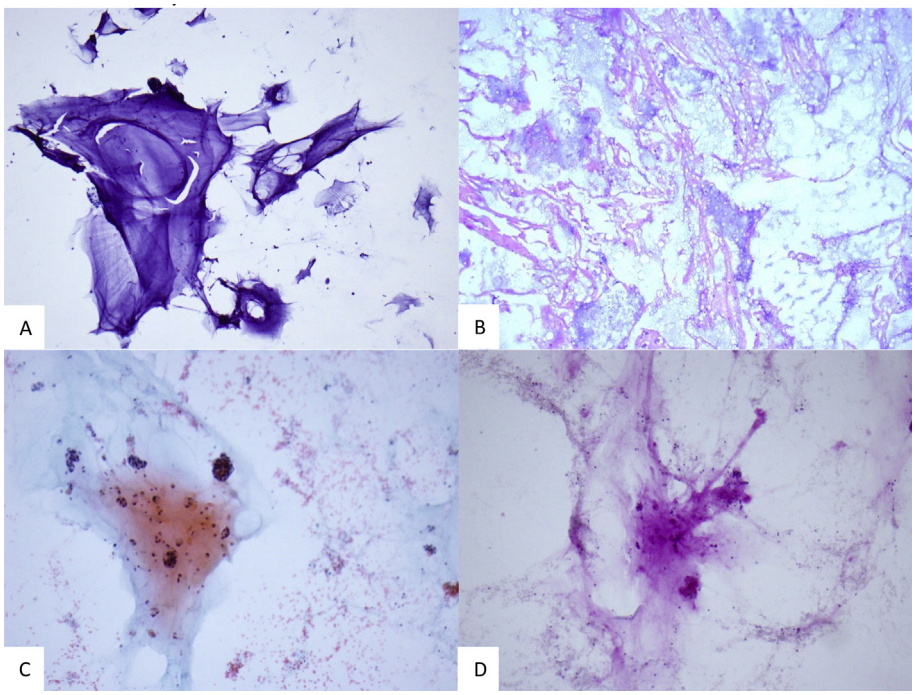

Fig. 2 Comparison of artefact and true mucin on cytology preparations. (A) Cytospin (Papanicolaou stain) and (B) cell block (H&E) preparations showing mucin-like artefact (peritoneal washings from a 69-year-old female who underwent hysterectomy for atypical endometrial hyperplasia). (C) Papanicolaou and (D) periodic acid–Schiff smears showing true extracellular mucin (peritoneal washings from a patient with ovarian mucinous adenocarcinoma).

der Griend *et al.*[2] identified this artefact in Lifehealthcare Serres liner bags. Quinn *et al.*[3] tested Vacsax branded liner bags and tubing by agitating warm and cold saline, and preparing cytospin preparations. The artefact was encountered only in the saline obtained from the liner bags, not the tubing.

Raising awareness of this distinct artefact in cytology specimens obtained from suction canister liner bags is important for the cytologist and cytopathologist to avoid misinterpretation. Knowledge of the artefact makes it readily identifiable in the setting of discordance with the other cytological findings and clinical features; however, it could be problematic when the clinical setting of excluding intra-abdominal mucin is less certain. Our findings highlight the artefact is not limited to the collection devices previously described. Identification of such artefact should prompt discussion between the laboratory and surgical theatre to explore the use of alternative collection containers.

Acknowledgements: The authors thank Ms Susan Jones and the cytology laboratory staff at Austin Pathology for their input and technical assistance.

Conflicts of interest and sources of funding: The authors state that there are no conflicts of interest to disclose.

Melisa Vazquez, Marsali Newman

Anatomical Pathology, Austin Pathology, Heidelberg, Vic, Australia

Contact Dr Melisa Vazquez.
E-mail: melisa.vazquez@y7mail.com

1. Rodriguez EF, Monaco SE, Khalbuss W, *et al*. Abdominopelvic washings: a comprehensive review. *Cytojournal* 2013; 10: 7–45.
2. van der Griend R, Lamb D, Challis D, *et al*. A mucinous mimic: identification of a distracting artefact. *Cytopathology* 2011; 22: 133–4.
3. Quinn G, Hales S, Hamid B, *et al*. Comparison of mucoid-mimic artefact with true mucin in peritoneal cytology samples. *Cytopathology* 2015; 26: 194–6.

DOI: https://doi.org/10.1016/j.pathol.2018.12.422

Insidious *plumbum*

Sir,

As a department we frequently report blood lead concentrations to the Chief Health Officer, however a recent case of familial lead toxicity has caused great concern. A clinician reported that a local family of six, including four children ranging in age from 3 months to 16 years, had been referred for management of lead toxicity and wanted our input. This prompted a review of the literature pertaining to lead toxicity where we uncovered some concerning facts.

The index patient was an 8-year-old child who was seen by her primary care physician due to difficulty with maintaining focus at school and disruptive behaviour. Her physical examination, including neurological examination, was unremarkable. She had no physical symptoms of concern. Her physician requested laboratory investigations including a blood lead level.

The child was iron replete with a normal thyroid stimulating hormone concentration. Her blood lead was significantly elevated at 11.6 µg/dL (0.560 µmol/L). A blood film was not initially requested. She was referred to a paediatrician at a nearby hospital for further management and a statutory notification was made to the Chief Health Officer of Queensland as is required for blood lead levels greater than 5 µg/dL (0.241 µmol/L).

Blood lead in the remaining family members was measured: 19.9 µg/dL (0.961 µmol/L) in the youngest sibling, 37.7 µg/dL (1.820 µmol/L) in the second youngest child of 21 months, 14.9 µg/dL (0.719 µmol/L) in the eldest child and 5 µg/dL (0.241 µmol/L) and 19.5 µg/dL (0.942 µmol/L) in the mother and father, respectively. The entire family had been exposed to lead, calling to question the source of this exposure.

There was no known source of environmental exposure such as we have seen in recent times in Mount Isa, Port Pirie and Broken Hill. However, there were some unique features relating to the family home. The home was built circa 1920 when lead-based paint was in common use and had been relocated next to a major highway. Furthermore, it had been significantly damaged in a category 4 cyclone leading to major repair works 2 years prior. We know that lead persists in the environment unless conscientiously removed, we also know that disruption to lead containing products, for example from cyclone damage, causes environmental contamination with well-established consequences to human health. Despite the phasing out of leaded fuel, lead contamination has been detected adjacent to major roads in recent times. These facts pointed to the family home as the most likely source.

We know that infants and children are more vulnerable to environmental lead exposure compared to adults. Lead can cross the placenta and is excreted in breast milk. Children have a higher gastric uptake of lead combined with reduced renal excretion.[1] Those with iron deficiency absorb greater amounts lead via the gut due to the increased activity of the divalent metal transporter 1 in addition to the ingestion of lead containing soil secondary to pica.[2,3] Toddlers are particularly at risk given their propensity to suck fingers and household items with increased time spent on the floor.

The Public Health Unit, a Government funded health promotion agency, investigated the family home for traces of lead. These results are presented in Table 1 together with the actionable levels that require further investigation.[4,5] Evidently, this investigation confirmed that the family home had been the source of exposure. Not only were high lead levels found in the water tanks from which the family drank, but it was present in astoundingly high levels in the soil surrounding the home, the floors and windows, including in the children's bedrooms. The family promptly relocated and lead-eradication procedures were initiated. It was later confirmed that lead had been adequately removed through repeat sampling (Table 1).

All family members had their blood lead levels repeated periodically and none required chelation therapy. All children continue to show elevated blood lead levels, however they are slowly decreasing over time. All children had at least one assessment of their full blood count, blood film and iron studies. The child with the highest blood lead concentration, the second youngest child, was iron deficient with a ferritin of 8 ng/mL (18 pmol/L). Iron supplementation was commenced. The remaining children were iron replete with normal morphology.

To understand why the children's blood lead levels were slow to decrease despite the removal of lead in the home, the kinetics of lead in the body must be addressed. The half-life of lead in the blood is 35 days, 50 days in the soft tissue and in bone 20−30 years.[6] The time required for blood lead to decline in children is thought to be proportional to the degree and length of lead exposure. This is directly related to lead in the bone pool which interacts with the blood contributing to the blood lead level well beyond the expected half-life of lead in the blood and soft tissue. It is difficult to project how quickly lead levels should be falling in non-chelated children because there is a non-linear relationship between peak lead and the time taken for the peak level to halve.[7] We will continue to monitor these children.

The history of lead toxicity is notable. Lead mining and the domestic use of lead-containing products has been a feature of human civilisation for at least 6000 years.[8] Analysis of glacial core samples have convincingly demonstrated the link between industrial activity and environmental contamination with a macabre decrease corresponding to a Black Death pandemic during which mining diminished (Fig. 1).[9]

Table 1 Lead levels detected in the family home compared to previously published acceptable limits

Site (sample/swab)	Prior to lead removal	Following lead removal	Acceptable limit[4,5]
Water	0.0077−0.024 mg/L	0.0077−0.0085 mg/L	0.01 mg/L
Soil	440−14,000 mg/kg	16−1,600 mg/kg	300 mg/kg
Floor	1,900−12,000 µg/m^2	70−810 µg/m^2	1,000 µg/m^2
Interior windows/ledges	1,700−83,000 µg/m^2	40−1,800 µg/m^2	5,400 µg/m^2

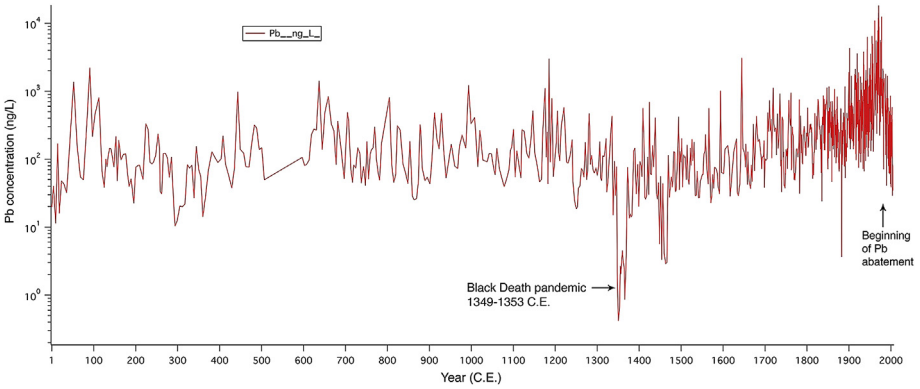

Fig. 1 Lead concentration in Colle Gnifetti ice core, from high-resolution discrete ICP-MS.[9]

A depressing feature of this history is the cyclical rediscovery of the toxic effects of lead throughout the millennia. Although the Egyptian, Greek and Roman civilisations were aware of the link, it was forgotten and rediscovered in the Middle Ages and again in the 17th and 18th centuries.[8] Incredibly, the earliest cases of paediatric lead toxicity were described by two Brisbane physicians in 1892. One of these physicians, Dr J. L. Gibson, was later the first to identify the causative link between lead toxicity and household paint.[10,11] This discovery led to the eventual prohibition of lead-based paint in the first world.

The phenotypic presentation of lead toxicity has changed dramatically over the centuries however the adverse effects of lead are well established, even at levels previously thought to be 'low'. Our knowledge of the perils of lead continues to evolve with a recent paper concluding that low-level lead exposure is an important and usually overlooked risk factor for cardiovascular disease mortality.[12] This case raises the question of how many children are being exposed to lead unknowingly in areas thought not to pose a significant risk. The only lead screening programs we are aware of operating in Australia currently are in Port Pirie and Broken Hill.

Alarmingly, more than a century following the discovery of paediatric lead toxicity we are still being exposed to lead both from mining and smelting in some of our communities but also insidiously in homes Australia-wide.

Acknowledgements: We would like to thank Barbara Mathews and Professor Alison Jones.

Conflicts of interest and sources of funding: The authors state that there are no conflicts of interest to disclose.

Gemma Maree Daley[1], Cheriya Abdulla[2], Carel J. Pretorius[1,3], Jacobus P. J. Ungerer[1,3]

[1]Department of Chemical Pathology, Pathology Queensland Central Laboratory, Brisbane, Qld, Australia; [2]Department of Paediatrics, Rockhampton Base Hospital, Rockhampton, Qld, Australia; [3]Faculty of Medicine, University of Queensland, Brisbane, Qld, Australia

Contact Dr Gemma Maree Daley.
E-mail: daley.gemma@gmail.com

1. Koyashiki GA, Paoliello MM, Tchounwou PB. Lead levels in human milk and children's health risk: a systematic review. *Rev Environ Health* 2010; 25: 243–53.
2. Akkus C, Ozdenerol E. Exploring childhood lead exposure through GIS: a review of the recent literature. *Int J Environ Res Publ Health* 2014; 11: 6314–34.
3. Andrews NC. The iron transporter DMT1. *Int J Biochem Cell Biol* 1999; 31: 991–4.
4. New South Wales Environment Protection Authority. Managing lead contamination in home maintenance, renovation and demolition practices: a guide for councils. Feb 2003; cited 15 Sep 2017. http://www.environment.nsw.gov.au/resources/pesticides/03004managinglead.pdf
5. National Resource Management Ministerial Council. *Australian Drinking Water Guidelines 6, 2011*. Canberra: National Health and Medical Research Council; 2011. https://www.nhmrc.gov.au/guidelines/publications/eh52
6. Rabinowitz MB, Wetherill GW, Kopple JD. Kinetic analysis of lead metabolism in healthy humans. *J Clin Invest* 1976; 58: 260–70.
7. Roberts JR, Reigart JR, Ebeling M, *et al*. Time required for blood lead levels to decline in nonchelated children. *J Toxicol Clin Toxicol* 2001; 39: 153–60.
8. Lessler MA. Lead and lead poisoning from antiquity to modern times. *Ohio J Sci* 1988; 88: 78–84.
9. More AF, Spaulding NE, Bohleber P, *et al*. Next-generation ice core technology reveals true minimum natural levels of lead (Pb) in the atmosphere: insights from the black death. *Geo Health* 2017; 1: 211–9.
10. Gibson JL, Love W, Hardie D, *et al*. Notes on lead poisoning as observed among children in Brisbane. *Proc Intercolonial Med Congr Aust* 1892: 78–83.
11. Gibson JL. A plea for painted railings and painted walls of rooms as the source of lead poisoning amongst Queensland children 1904. *Publ Health Rep* 2005; 120: 301–4.
12. Lanphear BP, Rauch S, Auinger P, *et al*. Low-level lead exposure and mortality in US adults: a population-based cohort study. *Lancet Publ Health* 2018; 3: e177–84.

DOI: https://doi.org/10.1016/j.pathol.2018.11.017

Is total iron binding capacity (TIBC) calculation correct?

Sir,
As part of serum/plasma investigations to determine iron status, total iron binding capacity (TIBC) is an important calculation to determine percentage transferrin (TRF) saturation. TRF saturation may be the earliest indicator of iron overload and a low TRF saturation in the setting of an equivocal ferritin level is suggestive of iron deficiency. Serum/plasma TIBC (µmol/L) values could be either obtained from a calculation or measured by the amount of iron required to saturate the specimen. When TIBC is determined by calculation, the iron transport protein, TRF concentration (g/L), is multiplied by a conversion factor. Calculation has taken molecular mass and iron binding capacity of TRF into consideration to generate TIBC results in µmol/L.

The principle author noted that their laboratory results were quite high compared to other laboratories in the Royal College of Pathologists of Australasia Quality Assurance Programs (RCPAQAP) in 2017. TIBC is reported in the General Chemistry and Therapeutic Drugs and in the Liquid Serum Chemistry programs. According to RCPAQAP, allowable limit of performance (ALP) is set as ±4.0 µmol/L up to 50.0 µmol/L; ±8% >50.0 µmol/L. The author noted when medians of TIBC were 46 g/L and 66 g/L in one interim report, the author's laboratory results were 54 g/L and 87 g/L, respectively. The same pattern was seen across other interim reports as well. Further analysis revealed differences in TIBC conversion factors. The conversion factors of 25, 23, 22 and 'other factor' were listed as possible options to obtain the TIBC from TRF level. Factor 25 has been employed by the principle author's laboratory. By 2018, of all 37 laboratories reporting TIBC in RCPAQAP, 23 used this calculation. The rest of the results were generated by direct measurements. Vitros (Ortho Clinical Diagnostics, USA), AU 5800 (Beckman Coulter, USA) and Integra (Roche, Switzerland) used factor 25; whereas factor 23 was used by Cobas c (Roche) and UniCel DxC600 (Beckman Coulter). The 'other factor' was used mainly by Architect (Abbott, USA) and by one Cobas c user. The 'other factor' group comprised the major group with 18 laboratories in 2018. This cohort created two groups generating higher and lower results. The results of the 'higher subgroup' which was only three laboratories were seen above the RCPAQAP allowable performance specification (APS) limits. The result of factor 25 was seen among 'higher subgroup' results, whereas the results of the 'lower