Kimberley Aboriginal Health Planning Forum

Kimberley Public Health Planning Report

Hospitalisations in 2016 of Aboriginal people due to their environment:

Demand, costs and Kimberley solutions

FINAL VERSION
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EXECUTIVE SUMMARY

Elsewhere, it has been shown that environmental determinants are a major contributor to caseload in primary health care in the Kimberley (McMullen et al 2016). In this report, data for hospitalisations of Aboriginal people in the Kimberley for 2016 were analysed. As explained in detail here, there is a high number of hospitalisations due to environmental determinants in the Kimberley and many days spent in hospital. Costs of hospitalisations directly due to the environment for Aboriginal people of all ages in 2016 was $16,930,056.00. This represented 26% of the entire budget spend on hospitalisations for Aboriginal people from the Kimberley. Costs of hospitalisations directly due to the environment for Aboriginal in 2016 directly attributable to the environment (Aboriginal children 0-14 years) in 2016 was $3,162,535.00. This represented 32% of the entire budget spend on hospitalisations for Aboriginal children from the Kimberley. These findings are timely with the release in January 2018 of the Interim Report of the Panel for the WA Government's Sustainable Health Review (SHRP 2018). Of 12 strategic directions put forward in this Interim Report, Direction 1 states: **Keep people healthy and get serious about prevention and health promotion** (SHRP 2018). This SHR Panel acknowledged that a 'whole-of-system' approach is required, further noting '… a shift to more mature funding options or incentives to promote efficient prevention'. This SHR Panel also recognized that '… health outcomes of Aboriginal people, more than almost any other population, have been disproportionately impacted by the social determinants of health. A number of submissions to the Review focused on addressing the social determinants of health through partnerships. Partnerships between State and Commonwealth health agencies, non-government organisations and Aboriginal organisations will be vital in addressing these social determinants and achieving shared goals'. In its submission to this review, the Aboriginal Health Council of Western Australia (AHCWA 2017) recommended 'Increased investment in "wellness", prevention and early intervention (including Environmental Health for Aboriginal communities)' as a key priority for sustainability. Importantly, the WA Country Health Service (WACHS) acknowledged in its submission to this review that the environment contributes to poorer health outcomes and inequity. In turn, this disparity requires investment in partnerships and innovation (WACHS 2017).

INTRODUCTION

Environmental determinants of health and disease

As defined by one organization, namely the World Health Organisation (WHO), the environment is *'all the physical, chemical and biological factors external to the human host, and all related behaviours, but excluding those natural environments that cannot reasonably be modified' (*Prüss-Üstün & Corvalán 2006).

This definition is not all-inclusive of everything in the environment. By contrast, it is a definition purposefully specified by WHO to inform and galvanise public health practice. As used in health contexts by WHO, *'the environment'* refers to those aspects that are *'modifiable'* – perhaps not necessarily immediately but certainly with solutions that are already available and known to be effective (see detail in Table 1). A related definition is that of environmental health. According to Flinders University, environmental health is *'the study of how the environment impacts on our health – the physical, biological, chemical and sociological factors external to us that determine our health and wellbeing. Environmental health is the branch of public health that is concerned with all aspects of the natural and built environment that affect our health, such as water, food, air, buildings and waste'.*

When an environmental factor is addressed or removed from the environment, the overall number of health problems or deaths in the community due to this environmental factor will decline predictably: the underlying concept of this predictable, proportional reduction in the number of health problems or deaths as a result of reducing the environmental determinant is known as the *'environmental attributable fraction'.* In other words, the *'environmental attributable fraction'* will be the proportion of all health problems or deaths in the community that can be attributed to the modifiable environment *(*Prüss-Üstün & Corvalán 2006). These authors also acknowledge that attributing the health impacts of environmental conditions at population level is a foundation of public health practice (Prüss-Üstün & Corvalán 2006). Their own estimates at a global level for WHO demonstrated how much death, illness and disability could realistically be avoided every year if environmental hazards were addressed. These environmental factors include physical, chemical and biological hazards that directly affect health and also those that increase unhealthy behaviours such as impeding physical activity at health-promoting levels or poor sanitation or homes with inadequate plumbing and hardware.

In Australia, Pholeros and his colleagues had earlier established the prevalence of inadequate home environments for Aboriginal people living in remote settings and, importantly, showed the reduction in certain specific hospitalisations of Aboriginal people when this aspect of their environment was remedied (Pholeros 1994; Torzillo et al 2002; Torzillo et al 2008; Pholeros et al 2013). This approach tackling environmental determinants is known as *'primordial prevention'.* In his comprehensive report to the WA Health Department, *A Promising Future: WA Aboriginal Health Programs,* Prof D'Arcy Holman showed that environmental factors were likely responsible for 13% of the overall gap in mortality between Aboriginal and non-Aboriginal people in WA (PYLL$_G$). He further estimated that environmental health interventions for Aboriginal people in Western Australia were funded at only around one half of their levels of priority (Holman 2014). His review also noted that environmental health in country regions was a service *'consistently viewed by a diverse range of stakeholders as under resourced relative to need'.* In constructing the case for greater investment in environmental health, Prof Holman also referred to the findings of a project that had estimated the disease burden in the Kimberley directly due to the environment that was nearing completion when presented to his review team on 1 September 2014 in Broome by a team from the Kimberley Population Health Unit (KPHU). Appendix 1 summarises

the methods and findings of this Kimberley-based project reported in full in in 2016 in an article published in the *Australian & New Zealand Journal of Public Health* (ANZJPH).

Environmental health partnerships in the Kimberley

On 2 December 2014, the Kimberley Aboriginal Health Planning Forum (KAHPF) agreed to create an Environmental Health SubCommittee as a result of advocacy by Nirrumbuk Aboriginal Corporation. Further information can be found at http://www.kahpf.org.au/kahpf-subcommittees/

During various presentations and discussions during 2017, members of this KAHPF Environmental Health Subcommittee identified the need to estimate the costs of hospitalizations of Aboriginal people in the Kimberley for diseases due to the environment. To do so, the method previously established whereby the demand observed for each specific disease is multiplied by its KEAF in order to establish the proportion directly attributable to environmental determinants could be applied to hospitalization data. This report presents the method and results of this work, sharing our findings, interpretation and recommendations. Please note that 'hospitalisations' are frequently referred to as 'separations' or 'admissions' and these terms may be used interchangeably in this report according to the respective data source. Wherever possible, this word substitution has been applied.

METHOD

We submitted a data request to the Purchasing and System Performance Division of the WA Department of Health, working together to determine a suite of ICD-10 codes matching the 46 diseases for which KEAFs had been determined (see Appendix 2). For example, 'Skin Infections' comprised five mutually exclusive codes. Separations were confined to Aboriginal and/or Torres Strait Islander patients (indstat 1-3) with Kimberley residential postcodes 6725, 6726, 6728, 6740, 6743, 6765 or 6770. Separations from all WA public and private hospitals were included except for cancelled procedures, healthy newborns, posthumous organ procurements, boarders, aged care residents, non-WA hospitals (such as Darwin hospital) and funding hospital (duplicate) cases. Further dialogue between the Purchasing and System Performance Division clarified the selection of ICD-10 codes for each of our diagnostic categories, avoiding overlap and double-counting. We further specified code numbers taking a conservative approach to any code for which we were uncertain of its relationship to the disease for which we had a KEAF. This specific attention was afforded 'Perinatal infections', 'STIs' and 'Urinary Tract Infections' before the final datasets were generated. These datasets necessarily excluded death data (in other words, a person who had suicided and was dead on arrival at hospital would not be counted in these data, nor was a perinatal death). However, attempted suicide was captured in X60-X84 Intentional Self-Harm. Once these ICD-10 codes were agreed, Division staff in the WA Department of Health extracted these data from the Hospital Morbidity Data Collection (Inpatient Data Collections) for 2016 by five-year age bands (0-4 years; 5-9 years etc). We obtained further clarification from the Purchasing and System Performance Division about several issues. There can be only one Principal Diagnosis per separation in the Hospital Morbidity Data Collection (Inpatient Data Collections). Furthermore, codes for External Causes of Morbidity and Mortality already applied to show the cause of injuries are not used as a Principal Diagnosis in certain circumstances such as Injury and Poisoning. In the case of 'Falls', a diagnosis code for injuries already had been used by the Division coders with an external cause code indicating a fall.

Coders assign one **Principal Diagnosis** for each hospitalisation, based on information in clinical data systems. As defined in the Australian Coding Standards, the Principal Diagnosis is *'the diagnosis*

established after study to be chiefly responsible for occasioning an episode of admitted patient care, an episode of residential care or an attendance at the health care establishment, as represented by a code' (METeOR: 514273) (Australian Institute of Health and Welfare, 2014). We received a dataset for **Principal Diagnosis** for hospitalisations of Aboriginal people resident in the Kimberley in 2016. The Division also provided their **cost estimates** for these hospitalisations using their standard cost formula based on estimates from the Independent Hospital Pricing Authority (IHPA) for each entire admission. The Division's cost estimates are generated using the Independent Hospital Pricing Authority national public sector estimated average costs for Diagnosis Related Groups v7.0 (Round 18 2013-14) based on public hospitals. It should also be noted that these costs were for separations where the condition specified was listed as the Principal Diagnosis for the hospitalisation, and are not the costs associated with specifically providing care for the specified condition alone.

Using this Principal Diagnosis dataset, we noted admissions for any of the 46 diseases listed in Table 2. As reported in McMullen et al (2016), each of these 46 diseases has a value greater than zero for their respective environmental attributable fraction in the Kimberley (see Table 2). These values are known as KEAFS (Kimberley Environmental Attributable Fractions). For each disease, we summed admissions, lengths of stay and costs as provided by the Purchasing and System Performance Division of the WA Department of Health for all patients in total and also for the subset of patients aged between 0 and 14 years of age. We then multiplied these by the respective KEAF to calculate how much of each was directly attributable to the environment. An identical method had been used earlier by Ward & Girgis (2003) to estimate the costs of hospitalizations directly due to tobacco use.

As provided by the WA Department of Health, small numbers were not suppressed in order to undertake the environmental fractions analysis. Conditions of access to the dataset however required us to suppress those counts where values were < 5. Ethics committee applications were not required as this analysis was conducted for planning not publication purposes.

RESULTS

Overall, there were 26,292 hospitalisations in the calendar year 2016 for Aboriginal people of any age resident in the Kimberley. Overall, these cost $66,265,354.00. For children 0-14 years resident in the Kimberley, there were 1,938 hospitalisations. Overall, these cost $9,894,649.00. How much of this expense was due to the environment?

As shown in Table 2, there was at least one hospitalisation in 2016 as Principal Diagnosis for 38 out of 46 diseases for which a KEAF had been established. There were no hospitalisations for any age with a Principal Diagnosis of the eight other conditions for which we also had KEAFs, namely trachoma, Ross River Virus, Murray valley encephalitis or Barmah Forest Virus, musculoskeletal, perinatal deaths, low birth weight or intestinal nematodes.

For each of these 38 Principal Diagnoses for which there had been at least one hospitalisation and for which we had an established KEAF, we calculated the number of hospitalisations, bed days and costs to be directly attributed to the environment by multiplying by the respective KEAF. Box 1 on the next page shows a worked example.

One worked example in detail

As shown in Table 2, the Kimberley Environmental Attributable Fraction (KEAF) for ARF is 0.80. In other words, 80% of ARF in the Kimberley is directly attributable to the environment (McMullen et al 2016). Our calculations as reported here were undertaken as follows:

0-14 yrs

- 30 hospitalisations for which ARF was the Principal Diagnosis of which 24 (30 x .8) are calculated using ARF KEAF as attributable to the environment
- 243 bed days for hospitalisations for which ARF was the Principal Diagnosis of which 194 (243 x .8) are calculated using ARF KEAF as attributable to the environment
- $180,897.00 in costs for hospitalisations for which ARF KEAF was the Principal Diagnosis of which $144,718.00 ($180,897.00 x .8) as attributable to the environment

All ages

- 40 hospitalisations for which ARF was the Principal Diagnosis of which 32 (40 x .8) are calculated using ARF KEAF as attributable to the environment
- 267 bed days for hospitalisations for which ARF was the Principal Diagnosis of which 214 (267 x .8) are calculated using ARF KEAF as attributable to the environment
- $241,742.00 in costs of which $193,394.00 ($241,742.00 x .8) are calculated using ARF KEAF as attributable to the environment

Table 3 shows important detail for all diseases for Aboriginal children hospitalised in 2016 for a disease having some component of attribution due to the environment. As can be seen in Table 3, the number of hospitalisations for Aboriginal children in 2016 for Principal Diagnosis is displayed and, in the next column, the number directly attributable to environmental determinants after applying the respective KEAF. Table 3 also shows these calculations for bed days (length of stay). Table 4 displays the number of hospitalisations for all Aboriginal people (adults and children) in 2016 for Principal Diagnosis and, as above for each, the number directly attributable to environmental determinants after the respective KEAF was applied. Table 4 also shows these calculations for bed days.

As shown in Table 5, costs of hospitalisations directly due to the environment are:

➢ **Costs for hospitalisations in 2016 directly attributable to the environment (all ages) = $16,930,056.00**

➢ **Costs for hospitalisations in 2016 directly attributable to the environment (Aboriginal children 0-14 years) = $3,162,535.00**

Remembering that 26,292 hospitalisations in 2016 for Aboriginal people resident in the Kimberley in WA hospitals cost $66,265,354, we can conclude that 26% of entire hospitalisation cost is directly attributable to environmental determinants (ie $16,930,056.00÷$66,265,354.00). For children 0-14 years resident in the Kimberley, there were 1,938 separations directly due to the environment that cost $9,894,649.00. This is 32% of the total amount spent on hospitalisations for Aboriginal children from the Kimberley in 2016 (ie $3,162,535.00÷$9,894,649.00).

DISCUSSION

Elsewhere, it has been shown that environmental determinants are a major contributor to caseload in primary health care (McMullen et al 2016). In this report, we show a high demand for hospitalisations due to environmental determinants in the Kimberley which lead to many days in hospital (known as lengths of stay). Furthermore, their overall cost in 2016 exceeded $16 million. Of greatest concern, approximately one third of the costs incurred by WA Health for hospitalisations of Aboriginal children 0-14 years resident in the Kimberley in 2016 was due directly to environmental determinants.

These findings are timely with the recent release in January 2018 of the Interim Report of the Panel for the WA Government's Sustainable Health Review (SHRP 2018). Of 12 strategic directions put forward in this Interim Report, Direction 1 states: **Keep people healthy and get serious about prevention and health promotion** (SHRP 2018). This SHR Panel acknowledged that a '*whole-of-system*' approach is required, further noting '*… a shift to more mature funding options or incentives to promote efficient prevention*'. This Panel also recognized that '*… health outcomes of Aboriginal people, more than almost any other population, have been disproportionally impacted by the social determinants of health. A number of submissions to the Review focused on addressing the social determinants of health through partnerships. Partnerships between State and Commonwealth health agencies, non-government organisations and Aboriginal organisations will be vital in addressing these social determinants and achieving shared goals'.* In its submission to this review, the Aboriginal Health Council of Western Australia (AHCWA 2017) recommended '*Increased investment in "wellness", prevention and early intervention (including Environmental Health for Aboriginal communities)'* as a key priority for sustainability. WACHS also acknowledged in its submission that the environment contributes to poorer health outcomes and inequity. In turn, this disparity requires investment in partnerships and innovation (WACHS 2017).

As affirmed by Prüss-Üstün et al (2016), disease can be prevented through healthier environments. The KAHPF Environmental Health SubCommittee has been informed of reductions over time in budget allocations to Aboriginal environmental health (from $9million to $7million currently). State-wide allocations affect shires as well. Instead, a recommendation is made that at least 10% of the amounts shown here could be used as the basis of additional funding for Aboriginal environmental health. Should $1.9 million be assigned to alternatives in the Kimberley such as primordial prevention to address environmental conditions and prevent BEFORE disease ever begins, then local Environmental Health Teams in the Kimberley could increase their staffing numbers and implement environmental health programs everywhere in collaboration with communities, bringing control over their environmental conditions. In addition, these teams would bring opportunities for meaningful, permanent Aboriginal employment. These teams could also work closely with local primary health care services to build community confidence in referrals from the clinic so that environmental factors can be explored in a culturally secure manner by environmental health experts.

While there are many aspects of the environment to be addressed in remote Australia, one aspect is highlighted further here, namely the quality of remote public housing. For example, AIHW (2017) references the Canadian National Occupancy Standard (CNOS) which measures the bedroom requirements of a household based on the number, sex, age and relationships of household members, specifically:
- no more than 2 people share a bedroom
- parents or couples may share a bedroom

- children under 5, either of the same sex or opposite sex, may share a bedroom
- children under 18 of the same sex may share a bedroom
- a child aged 5–17 should not share a bedroom with a child under 5 of the opposite sex
- single adults aged 18 and over and any unpaired children require a separate bedroom.

According to the CNOS, a residential dwelling requiring at least one additional bedroom is considered *'overcrowded'*. AIHW (2017) also confers a residential dwelling to be of *'acceptable'* standard if it has four (4) or more working facilities <u>and</u> if it has no more than two (2) major structural problems. Facilities are:
- stove/oven/other cooking facilities
- toilet
- washing machine
- laundry tub
- fridge
- bath or shower
- kitchen sink

Major structural problems include:
- rising damp
- sinking/moving foundations
- walls/windows out of plumb
- major electrical problems
- major roof defect
- major cracks to walls/floors
- sagging floors
- wood rot/termite damage
- major plumbing problems
- other structural problems.

As described elsewhere (AIHW 2017a), Tier 2 of the endorsed *'Aboriginal and Torres Strait Islander Health Performance Framework'* (HPF) describes Determinants of Health. AIHW (2017a) reports both bedroom requirements of a household and the standards arising from the combination of working facilities with structural problems in their residence as component of Environmental Health as part of the overall rubric of Tier 2. Data sources to measure and monitor these requirements are diverse including the Australian Aboriginal and Torres Strait Islander Health Survey, the National Aboriginal and Torres Strait Islander Social Survey and data from the Census of Population and Housing. Released by AIHW in 2017, the latest WA data show the current status of these Determinants of Health for Aboriginal people in our state (2017a). With respect to household bedroom requirements, 25% of Aboriginal respondents reported living in housing with insufficient bedrooms in 2014-2015 compared with 4% of non-Aboriginal people. In remote WA, this was 34%. Further, 21% of Aboriginal people reported living in dwellings that would be classified by the CNOS as being of 'unacceptable' standard. As also published (AIHW 2017a), 3.9% of Aboriginal people in WA reported they did not have access to facilities for washing people; 12% did not have access to facilities for washing clothes and bedding; 7.6% did not have access to facilities for preparing food; and 4.0% did not have access to working sewerage facilities in 2014-15.

Eradication of endemic skin infections including scabies as has occurred already in non-Aboriginal settings came about because of enforcement of minimum housing standards including plumbing,

affordable whitegoods, food security, changing community expectations and access to expert primary health care (Ware 2013; O'Donnell et al 2016; Ward 2016). Housing, public utilities and control over environmental conditions in which Aboriginal people are forced to live in order to reside on land that for centuries prior to European colonization belonged to their forebears will not be addressed by simplistic measures. Communities can work out what proportion of residential houses would be classified as *'over-crowded'* or not of *'acceptable'* standard. A certain proportion of houses in a specific community so classified should raise public health alarm as a place-based signal of increased risk for environmentally attributable diseases. With community mobilisation, support for responsive strategies would be further strengthened by public health expertise alongside community knowledge and environmental health teams. Once assessed, responsive redress should engage the respective housing authorities. Such an approach would be entirely consistent with the findings of Björkmann Nyqvist et al (2017) who demonstrated that provision of quantitative data with local communities in rural Uganda significantly increased local accountability and population impact. In a series of policy experiments initially reported by Björkman et al (2009) and Björkmann Nyqvist et al (2014), the most effective strategy combined information AND participation such that traditional methods to engage communities in public programs were combined with a report card of staff performance. Compared with participation alone, this combination of data and engagement was found to deliver significant improvements in health care delivery (such as utilization) and health outcomes (such as child mortality) after one year. These effects were sustained for more than four years. Thus, properly designed, efforts to stimulate community participation and local control can result in large and sustained improvements in health service provision and health outcomes in both the short and longer run. Ultimately, architecture of residential homes and other physical infrastructure in communities could be informed holistically by public health need as well as design and cost.

Such an approach is worthy of exploration in the Kimberley region. In 2016, a survey of all Kimberley-based Aboriginal environmental health service providers concluded that environmental health *'needs to be pushed from the top'* (KAHPF EH SubCommittee 2017). This survey also concluded that senior management in all health services in the Kimberley have a key role to play. Their support and reinforcement of the importance of environmental determinants and monitoring of key initiatives in raising awareness and prompting action on the ground is vital.

Further impetus for action is illustrated by the approach taken in New Zealand. In May 2017, the New Zealand Government announced ten targets for "Result Areas" for public service delivery were announced because *'delivering Better Public Services within tight financial constraints is an ongoing priority for the Government' (*see http://ssc.govt.nz/better-public-services-next-steps). These included **"Result Area 4: Safer kids"** that the Ministry of Health is leading with other Ministries including Housing New Zealand. This target sets an expectation of a 25% reduction by 2021 in hospital admission rates for a selected group of avoidable conditions in children aged 0 - 12 years with an interim target of 15% by 2019. These include admissions for respiratory conditions, bacterial skin infections and dental conditions. Achieving this result through effective inter-sectoral health and environmental action is expected to prevent approximately 4,900 hospital admissions by 2019 and another 3,300 by 2021: see https://nsfl.health.govt.nz/dhb-planning-package/better-public-services and https://www.health.govt.nz/publication/delivering-better-public-services-good-start-life

In response as cited in its own *Statement of Intent 2017-2021*, Housing New Zealand Corporation which supplies public housing is partnering effectively with local District Health Boards through agreed Alliance Leadership Team Charters. See https://www.hnzc.co.nz/publications/statement-of-intent/

Aside from health benefits and direct savings, imperatives for action on environmental determinants also come from other pressures on the health system. For example, the first of six national strategies recommended by the Global Antibiotic Resistance Partnership (GARP) is to reduce the need for antibiotics by improving access to clean water and functional sewerage systems, and ensuring a safe and healthful food supply (CDDEP 2015). As acknowledged by the WHO in its Global Action Plan on Antimicrobial Resistance, environmental aspects as a focus for local AMS committees should be a part of each nation's planning (WHO 2015; WHO 2016). This further cements the need for local capacity and control in environmental health.

Methodological aspects of hospitalisation costing studies

While the Kimberley is the first to develop environmental attributable fractions based on WHO values (McMullen et al 2016), we acknowledge that others use different methods to quantify hospitalisations for Aboriginal people due to the environment. For example, the latest *Overcoming Indigenous Disadvantage: Key Indicators 2014* report released by the Productivity Commission assumes that 100% of hospitalisations for selected diagnoses comprising influenza and pneumonia, diphtheria, intestinal infectious diseases, asthma and bacterial infections such as meningococcal infection are environmentally determined (SCRGSP 2017). By contrast, KEAFs recognise that such a claim for 100% attribution is questionable except for skin infections as explained in McMullen *et al* (2016). Quantifying attribution before application in studies of this type is well accepted in other issues of public health importance. For example, not all cases of lung cancer are attributable to smoking. Epidemiologists do not claim this. Rather, 90% of cases of lung cancer in men are attributable to smoking; similarly 37% of cases of stroke in men 65 years or younger are attributable to smoking for example. Hence, only 90% of costs of hospitalisations for lung cancer could be considered as due directly to tobacco (Girgis &Ward 2003). To calculate costs from avoidable hospitalisations and recommend an alternative investment in public health, this conservatism is more prudent (Girgis & Ward 2003). As another example of an effort to calculate caseload due to the environment, the 'Closing the Gap' Local Implementation Plan between the Fitzroy Crossing Community and the Commonwealth of Australia and the State of Western Australia (Version 2, 15th September 2010) produced by the Commonwealth of Australia stated that *'For diseases associated with poor environmental health, after adjusting for age differences, the observed number of Indigenous separations in Derby-West Kimberley SLA was more than 6 times the national average'*. However methodological details were not disclosed. As shown in Appendix 1, we believe that the transparency afforded by our publication of KEAFs in *ANZJPH* brings particular methodological strength to be adopted more widely.

It should also be noted that we did not examine costs whenever a disease for which there was a quantified KEAF contributed in other ways to hospitalization costs. To explain, an **Additional Diagnosis** can be added to the **Principal Diagnosis**. Such an additional diagnosis is defined as *'a condition or complaint either coexisting with the principal diagnosis or arising during the episode of admitted patient care, episode of residential care or attendance at a health care establishment, as represented by a code'* (METeOR: 514271) (Australian Institute of Health and Welfare, 2014). These additional diagnoses are interpreted as conditions affecting patient management in terms of requiring the commencement, alteration or adjustment of therapeutic treatment; diagnostic procedures and/or increased clinical care and/or monitoring. This report has been confined to Principal Diagnosis only. To ensure a conservative estimate, our analyses did not consider the data set for scenarios such as where a child might be admitted for lower respiratory tract infection but also co-infected at admission with a bacterial skin infection which extended their length of stay or complicated their inpatient management. Costs calculated here underrepresent the true costs to the WA health system. In addition, the costings

provided by WA Health do not include those incurred through the Patient Access Transport System (PATS) or financial expenses incurred by individuals themselves (accommodation, travel, loss of income etc). These costs do not include intangible costs such as time away from school for children and their risk of poor school progression. Finally, KEAFs were determined in the Kimberley originally in the context of community-based primary health care. Here, our method assumed direct applicability of KEAFs to hospitalization data. Refinements in future analyses using KEAFs might consider if a traffic light classification is required to quantify any more precisely the link between a community risk factor and hospitalization: for example, AIHW (2017b) classified the application of almost all occupational exposures as *'green'* or *'amber'* (*'reasonably'* applicable and *'possibly'* applicable respectively). Unfortunately, no environmental risk factors were considered (AIHW 2017b). Methods to further refine environmental determinants of Aboriginal health and wellbeing would be especially welcome if developed and used in partnership with Aboriginal communities and Aboriginal environmental health experts to garner their knowledge and ensure the necessary health perspectives are applied.

CONCLUSION

"Why treat people then send them back to the conditions that made them sick in the first place?"

Frank O'Donohoo
Then Co-ordinator
Environmental Health Program
Central Australia
2013 AMRRIC conference

"Prevention before presentation"

Ray Christophers & Chicky Clements
Nirrumbuk Aboriginal Corporation
Hot North presentation
Broome, 9 August 2017

ACKNOWLEDGEMENTS

Table 1

What is the 'environment'?

The environment is defined by WHO as *'all the physical, chemical and biological factors external to the human host, and all related behaviours, but excluding those natural environments that cannot reasonably be modified' (*Prüss-Üstün & Corvalán 2006)**#**

<u>Included</u> environmental factors are the modifiable parts (or impacts) of:

- pollution of air, water, or soil with chemical or biological agents;
- UV and ionizing radiation;
- noise, electromagnetic fields;
- occupational risks;
- built environments, including housing, land use patterns, roads;
- agricultural methods, irrigation schemes;
- man-made climate change, ecosystem change;
- behaviour related to the availability of safe water and sanitation facilities, such as washing hands, and contaminating food with unsafe water or unclean hands.

<u>Excluded</u> environmental factors are:

- alcohol and tobacco consumption, drug abuse;
- diet (although it could be argued that food availability influences diet);
- the natural environments of vectors that cannot reasonably be modified (e.g. in rivers, lakes, wetlands);
- impregnated bed nets (for this study they are considered to be non-environmental interventions);
- unemployment (provided that it is not related to environmental degradation, occupational disease, etc.);
- natural biological agents, such as pollen in the outdoor environment;
- person-to-person transmission that cannot reasonably be prevented through environmental interventions such as improving housing, introducing sanitary hygiene, or making improvements in the occupational environment.

*NOTE: The KAHPF Environmental Health SubCommittee recognises that there are other definitions of the 'environment' however this definition by WHO was the basis for this report.*

Table 2
Kimberley Environmental Attributable Fractions (KEAFs) for 46 diseases (listed alphabetically)

DISEASE CONDITION	KEAF TO BE APPLIED
Acute Rheumatic Fever (ARF)	.80
Asthma	.55
Cancer	.16
Cardiovascular disease (Not RHD)	.56
Cataracts	.70
Chronic lung disease incl. COPD	.12
Conjunctivitis (Infective)	.60
Deafness	.40
Dental caries, abscess, extractions	.60
Diarrhoeal diseases	.80
Drowning	.66
Failure to thrive	.60
Falls	.60
Fires/ burns	.30
Intestinal nematodes (hookworm)	.90
Keratoconjunctivitis	.80
Low birth weight	.27
Lower respiratory infections	.47
Malnutrition and nutritional concerns	.78
Mental health / psychosocial	.20
Miscarriage	.07
Murray Valley Encephalitis	.80
Musculoskeletal diseases	.25
Other arboviruses (Barmah Forest)	.80
Otitis Media	.90
Perinatal deaths	.05
Perinatal infections	.08
Poisonings	.20
Post-streptococcal glomerulonephritis	.75
Premature birth	.07
Pterygium	.80
Rheumatic heart disease (RHD)	.65
Road traffic accident	.60
Ross River Virus	.80
Scabies	.95
Shingles	.05
Skin cancer	.95
Skin infection incl. pustules, abscess, cellulitis, impetigo	#1.00
STD	.05
Suicide	.09
Throat infection	.80
Trachoma	.90
Tuberculosis	.33
Unintentional injuries incl. dog bite	.95
Urinary tract infection	.10
Violence	.25

Only one KEAF was determined by the skills-based panel to have a value of 1.0 or 100%: in this case, the skills-based panel considered factors in the Kimberley other than the environment were so small as to be negligible.

Table 3
Number and bed days of selected and total admissions in 2016 for Aboriginal children 0-14 years

DISEASE CONDITION	No of admissions	Total length of stay (bed days)	No of Admissions due to environment	Total number of bed days due to environment
Skin infection	159	407	159	407
Unintentional injuries incl. dog bite	150	324	143	308
Lower respiratory infections	135	325	63	153
Otitis Media	103	111	93	100
Dental caries, abscesses	89	105	53	63
Falls	65	128	39	77
Premature birth	53	614	4	43
Diarrhoeal diseases	46	82	37	66
Acute Rheumatic Fever (ARF)	30	243	24	194
Urinary tract infection	25	44	3	4
Scabies	18	70	17	67
Failure to thrive	18	128	11	77
Post-strep glomerulonephritis	17	79	13	59
Fires/ burns	17	95	5	29
Road traffic accident	16	25	10	15
Asthma	16	22	9	12
Violence	12	20	3	5
Chronic lung disease incl. COPD	12	103	1	12
Cardiovascular disease (Not RHD)	9	82	5	46
Malnutrition/ nutritional concerns	8	60	6	47
Perinatal infections	8	18	1	1
Poisonings	7	7	1	1
Suicide / self harm	7	24	1	2
Mental health / psychosocial	6	104	1	21
STD	6	14	0	1
Others#: Cancer Deafness Keratoconjunctivitis Throat infection RHD Conjunctivitis	13	32	7	18
Subtotal	1,045	3,266	709	1,828
ALL OTHER ADMISSIONS	893	2,090	N/A	N/A
TOTAL	1,938	5,356	709	1,828

1 but < 5 in one or both cells of actual admissions or length of stay precludes individual publication so summed for this group

Table 4 Number and bed days of selected and total admissions in 2016 for all Aboriginal people

DISEASE CONDITION	No of admissions	Total length of stay (bed days)	No of Admissions due to environment	Total number of bed days due to environment
Unintentional injuries incl. dog bite	720	2145	684	2038
Violence	695	1316	174	329
Lower respiratory infections	618	1712	290	805
Skin infection	527	1567	527	1567
Mental health / psychosocial	428	3090	86	618
Falls	345	1278	207	767
Cardiovascular disease (Not RHD)	342	1155	192	647
Urinary tract infection	197	519	20	52
Chronic lung disease incl. COPD	182	624	22	75
Dental caries, abscesses	137	270	82	162
Suicide / self harm	122	243	11	22
Otitis Media	115	134	104	121
Cancer	109	783	17	125
Diarrhoeal diseases	101	188	81	150
Cataracts	94	97	66	68
Road traffic accident	90	409	54	245
Asthma	87	138	48	76
Premature birth	53	614	3	43
Miscarriage	42	59	3	4
Acute Rheumatic Fever (ARF)	40	267	32	214
Fires/ burns	40	188	12	56
Malnutrition /nutritional concerns	39	101	30	79
Poisonings	30	51	6	10
Scabies	29	114	28	108
STD	21	46	2	2
Pterygium	20	23	16	18
Failure to thrive	18	128	11	77
Post-strep glomerulonephritis	17	79	13	59
RHD	16	132	10	86
Perinatal infections	8	18	1	1
Throat infection	8	12	6	10
Others# Deafness Skin Cancer Shingles Tuberculosis Keratoconjunctivitis Conjunctivitis Drowning	14	31	4	14
Subtotal	5,304	17,531	2,842	8,648
ALL OTHER ADMISSIONS	20,988	28,764	N/A	N/A
TOTAL	26,292	46,295	2,842	8,648

1 but < 5 in one or both cells of actual admissions or length of stay precludes individual publication so summed for this group

Table 5
Costs of hospitalisations in 2016 for Aboriginal people resident in the Kimberley directly due to environment

DISEASE CONDITION	Costs in 2016 children 0-14 yrs $	Costs in 2016 all ages $
Skin infection	740,304	3,045,193
Unintentional injuries incl. dog bite	645,077	4,137,489
Otitis Media	298,794	355,620
Lower respiratory infections	294,109	1,714,968
Dental caries, abscesses	168,959	303,748
Falls	149,872	1,265,709
Acute Rheumatic Fever (ARF)	144,718	193,394
Scabies	114,097	177,579
Diarrhoeal diseases	105,981	274,534
Post-strep glomerulonephritis	73,451	74,451
Premature birth	69,183	69,183
Cardiovascular disease (Not RHD)	61,166	1,660,564
Failure to thrive	59,456	59,456
Malnutrition and nutritional concerns	52,542	107,259
Fires/ burns	49,662	99,601
Road traffic accident	38,567	591,841
Asthma	28,964	185,612
Mental health / psychosocial	14,922	790,180
Urinary tract infection	9,756	90,221
Chronic lung disease incl. COPD	8,717	143,540
Violence	6,964	804,572
Poisonings	4,369	23,149
Deafness	4,264	4,264
Perinatal infections	3,910	3,910
Cancer	3,144	187,891
Suicide / self harm	2,988	53,575
Throat infection	2,491	18,282
Keratoconjunctivitis	2,033	2,033
Conjunctivitis	1,525	1,525
RHD	1,455	208,707
STD	1,095	3,672
Skin cancer	0	12,446
Intestinal nematodes (hookworm)	0	0
Trachoma	0	0
Murray Valley Encephalitis	0	0
Other arboviruses (Barmah Forest)	0	0
Pterygium	0	61,011
Ross River Virus	0	0
Cataracts	0	190,434
Drowning	0	4,920
Tuberculosis	0	3,085
Low birth weight	0	0
Musculoskeletal diseases	0	0
Miscarriage	0	6,617
Perinatal deaths	0	0
Shingles	0	824
TOTAL	3,162,535	16,930,056

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APPENDIX 1

Summary of the earlier work to determine Kimberley Environmental Attributable Fractions (KEAFs)

As described in full in McMullen et al (2016), KPHU aimed to establish environmental attributable fractions for specific diseases in the Kimberley. To do this, we designed a survey which presented the environmental attributable fraction for each disease as already published by WHO (Prüss-Üstün & Corvalán 2006), requesting the respondent's either agree with or revise this value. For diseases not considered by the WHO, our survey gave no values and instead asked for nominations of values from respondents. These values could range from 0 to 100%. This survey was administered to a diverse set of respondents including disciplines such as environmental health, paediatrics, general practice, community nursing, public health and remote area nursing. From 33 eligible respondents, we received 24 surveys (73% response rate). These responses were de-identified and collated. We then enlisted the expertise of a smaller, skills-based panel to which we presented mode, median, minimum and maximum values obtained through the survey. Our approach was designed to be consistent with the WHO model in which values for environmental attribution were established through a combination of known epidemiology, expert survey and consensus. This panel debated each disease and the respective data vigorously, settling on a consensus value for a Kimberley Environmental Attributable Fraction for each disease (KEAFs). For example, this panel agreed that 65% of RHD in the Kimberley was directly attributable to the environment (hence the KEAF for RHD is 65%). Only one KEAF – that for skin infection – was determined through this process to have a value of 100%. In this case, the skills-based panel considered factors in the Kimberley other than the environment were so small as to be negligible. By deciding a value for KEAF of 90% for otitis media, the panel recognised that anatomical variation contributes in part to the development of otitis media.

Publication of KEAFs complemented the subsequent update of the WHO environmental attributable fractions for global use (Prüss-Üstün et al 2016 p 68). In this 2016 WHO update, it was clearly argued by WHO that *'the realization of just how much disease and ill health can be prevented by focusing on environmental risk factors should add impetus to global efforts to encourage preventive health measures through all available policies, strategies, interventions, technologies and knowledge'* (Prüss-Üstün et al 2016). Having estimated values for KEAFs, KPHU had a tool to calculate health service workload directly attributable to the environment. In the second part of the project, we applied KEAFs to primary healthcare (PHC) clinic presentation data from 1 July 2012 to 30 June 2014 in order to estimate the workload directly attributable to the environment. This time period comprised more than 100,000 *'occasions of service'* provided in small remote clinics managed by WA Country Health Services (WACHS) in the Kimberley (McMullen et al 2016). For Aboriginal children aged 0-4 years, 25.6% of the PHC clinic caseload was directly attributable to the environment. For Aboriginal people of all ages, 23.1% of the PHC clinic caseload was directly attributable to the environment.

APPENDIX 2 Hospitalisations codes for 46 diseases with a Kimberley Environmental Attributable Fraction (KEAF) using coding frame ICD -10

DISEASE CONDITION	ICD-10 ACHI code(s)
Acute Rheumatic Fever (ARF)	I00 - I02 Acute rheumatic fever
Asthma	J45 Asthma J46 Status asthmaticus
Cancer	Cancer diagnoses are classified to: C00 - C96
Cardiovascular disease (Not RHD)	I51 Complications and ill-defined descriptions of heart disease I10 - I15 Hypertensive diseases I20 - I25 Ischaemic heart disease I30 - I52 Other forms of heart disease
Cataracts	H25 Senile cataract H26 Other cataract H28 Cataract and other disorders of lens in diseases classified elsehwere Q12.0 Congenital cataract
Chronic lung disease incl. COPD	J41 Simple and mucopurulent chronic bronchitis J42 Unspecified chronic bronchitis J43 Emphysema J44 Other chronic obstructive pulmonary disease J47 Bronchiectasis
Conjunctivitis (Infective)	H13.1 * Conjunctivitis in infectious and parasitic diseases classified elsewhere B30.1 Conjunctivitis due to adenovirus B30.9 Viral conjunctivitis, unspecified B30.2 Viral pharyngoconjunctivitis A74.0 Chlamydial conjunctivitis B30.3 Acute epidemic haemorrhagic conjunctivitis (enteroviral) B30.8 Other viral conjunctivitis A71.1 Active stage of trachoma
Deafness	H90 Conductive and sensorineural hearing loss H91 Other hearing loss
Dental caries, abscess, extractions	K02 Dental caries K04.7 Periapical abscess without sinus K04.6 Periapical abscess with sinus 97311-xx 97314-xx 97322-xx 97322-09 97322-10 97322-01 97323-xx 97324-xx
Diarrhoeal diseases	A00 - A09 Intestinal infectious diseases
Drowning	T75.1 Drowning and nonfatal submersion W65 - W74 Accidental drowning and submersion (these are the external cause codes). Other external cause code options for Drowning: V90 Accident to watercraft causing drowning and submersion, V92 Water-transport-related drowning and submersion without accident to watercraft, Y21 Drowning and submersion, undetermined intent.
Failure to thrive	R62.8 Other lack of expected normal physiological development
Falls	W00 - W19 Falls

Fires/ burns	T20-T31 Burns
Intestinal nematodes (hookworm)	B82 Unspecified intestinal parasitism B76 Hookworm diseases B77 Ascariasis B79 Trichuriasis B78 Stronglyoidiasis B81 Other intestinal helminthiases, not elsewhere classified B80 Enterobiasis B75 Trichinellosis B74 Filariasis
Keratoconjunctivitis	H16.2 Keratoconjunctivitis
Low birth weight	P07.0- Extremely low birth weight P07.1- Other low birth weight
Lower respiratory infections	J22 Unspecified acute lower respiratory infection J12 Viral pneumonia, not elsewhere classified J13 Pneumonia due to Streptococcus pneumoniae J14 Pneumonia due to Haemophilus influenzae J15 Bacterial pneumonia, not elsewhere classified J16 Pneumonia due to other infectious organisms, not elsewhere classified J17 Pneumonia in diseases classified elsewhere J18 Pneumonia, organism unspecified
Malnutrition and nutritional concerns	E40 - E46 Malnutrition
Mental health / psychosocial	Mental Health conditions as classified to: F00 - F99 Mental and behavioural disorders
Miscarriage	O03.0 Spontaenous abortion, Incomplete, complicated by genital tract and pelvic infection O03.1 Spontaenous abortion, Incomplete, complicated by delayed or excessive haemorrhage "O03.2 Spontaenous abortion, Incomplete, complicated by embolism " O03.3 Spontaenous abortion, Incomplete, with other and unspecified complications O03.4 Spontaenous abortion, Incomplete, without complication "O03.5 Spontaenous abortion, Complete or unspecified, complicated by genital tract and pelvic infection " O03.6 Spontaenous abortion, Complete or unspecified, complicated by delayed or excessive haemorrhage O03.7 Spontaenous abortion, Complete or unspecified, complicated by embolism O03.8 Spontaneous abortion, Complete or unspecified, with other and unspecified complications O03.9 Spontaenous abortion, Complete or unspecified, without complication O02.1 Missed abortion
Murray Valley Encephalitis	A83.4 Australian ecephalitis
Musculoskeletal diseases	-
Other arboviruses (Barmah Forest)	A94 Unspecified arthropod-borne viral fever A93 Other arthropod-borne viral fevers, not elsewhere classified A92 Other mosquito-borne viral fevrs
Otitis Media	H65 Nonsuppurative otitis media H66 Suppurative and unspecified otitis media H67 Otitis media in diseases classified elsewhere
Perinatal deaths	-
Perinatal infections	-
Poisonings	T36-T50 Poisoning by drugs, medicaments and biological substances

	X40- X49 Accidental poisoning by and exposure to noxious substances
Post-streptococcal glomerulonephritis	N00 - N07 Glomerular diseases - present with code B95.0
Premature birth	P07.2- Extreme immaturity P07.3- Other preterm infants
Pterygium	H11.0 Pterygium
Rheumatic heart disease (RHD)	I05 - I09 Chronic Rheumatic heart disease.
Road traffic accident	V00 - V99 Transport accidents
Ross River Virus	B33.1 Ross River Disease
Scabies	B86 Scabies
Shingles	B02.0 Zoster encephalitis B02.1 Zoster meningitis B02.2 † Zoster with other nervous system involvement B02.3 Zoster ocular disease B02.7 Disseminated zoster B02.8 Zoster with other complications B02.9 Zoster without complications
Skin cancer	C43 Malignant melanoma of skin C44 Other malignant neoplasms of skin
Skin infection incl. pustules, abscess, cellulitis, impetigo	L08.9 Local infection of skin and subcutaneous tissue, unspecified L08.8 Other specified local infections of skin and subcutaneous tissue L02 Cutaneous abscess, furuncle and carbuncle L03 Cellulitis L01 Impetigo
STD	A50-A64 Infections with a predominantly sexual mode of transmission
Suicide / self-harm	X60-X84 Intentional self harm
Throat infection	J02 Acute Pharyngitis
Trachoma	A71 Trachoma
Tuberculosis	A15-A19 Tuberculosis
Unintentional injuries incl. dog bite*	W20-W64, W75-X59
Urinary tract infection	N10 Acute tubulo-interstitial diseases N11 Chronic tubulo-interstitial nephritis N12 Tubulo-interstitial nephritis, not specified as acute or chronic N20 Calculus of kidney and ureter N21 Calculus of lower urinary tract N13.6 Pyonephrosis N15 Other renal tubulo-interstitial diseases O86.2 Urinary tract infection following delivery N28.8 Other specified disorders of kidney and ureter N30 Cystitis A06.8 Amoebic infection of other sites A36.8 † Other diptheria A52.7 † Other symptomatic late syphilis A59.0 † Urogenital trichomoniasis A18.1 † Tuberculosis of genitourinary system N34 Urethritis and urethral syndrome B37.4 † Candidiasis of other urogenital sites A56.0 Chlamydial infection of lower genitourinary tract A54.0 Gonococcal infection of lower genitourinary tract without periurethral or

	accessory gland abscess
	A54.1 Gonococcal infection of lower genitourinary tract with periurethral and accessory gland abscess
	A59.0 † Urogenital trichomoniasis
	A64 † Unspecifically sexually transmitted disease
	M02.3- Reiter's disease
	P39.3 Neonatal urinary tract infection
	O23 Infections of genitourinary tract in pregnancy
	N39.0 Urinary tract infection, site not specified
Violence	X85 - Y09 Assault