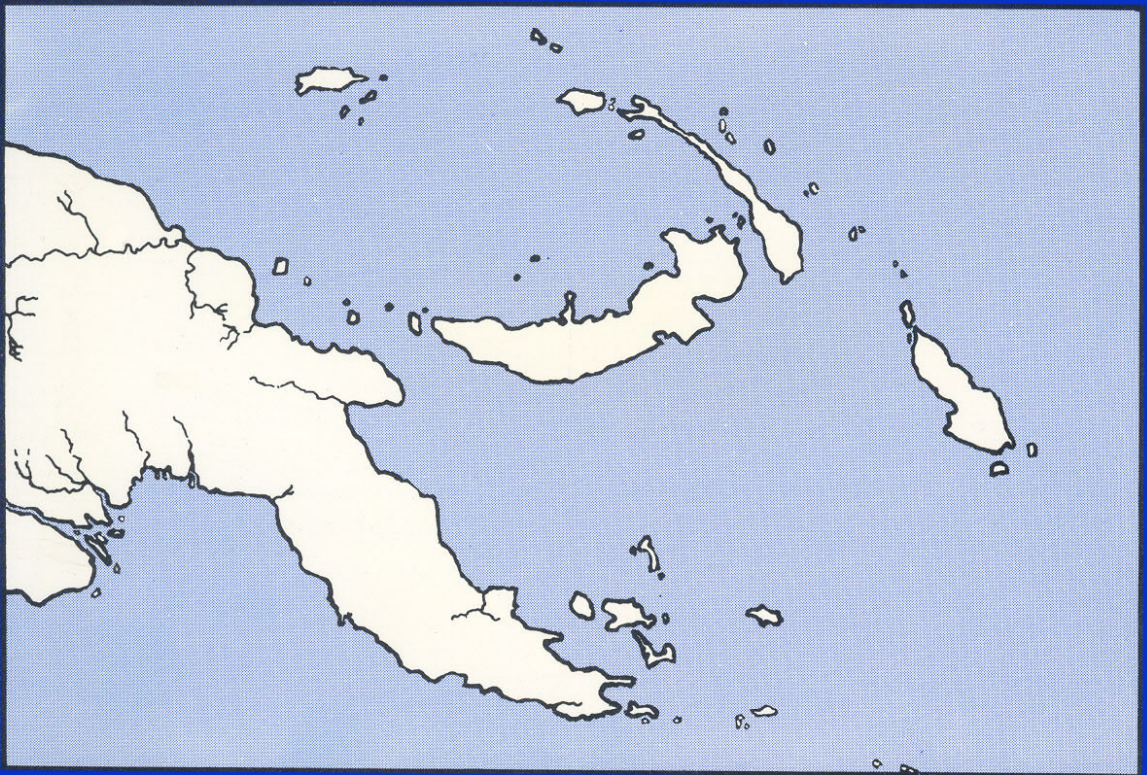


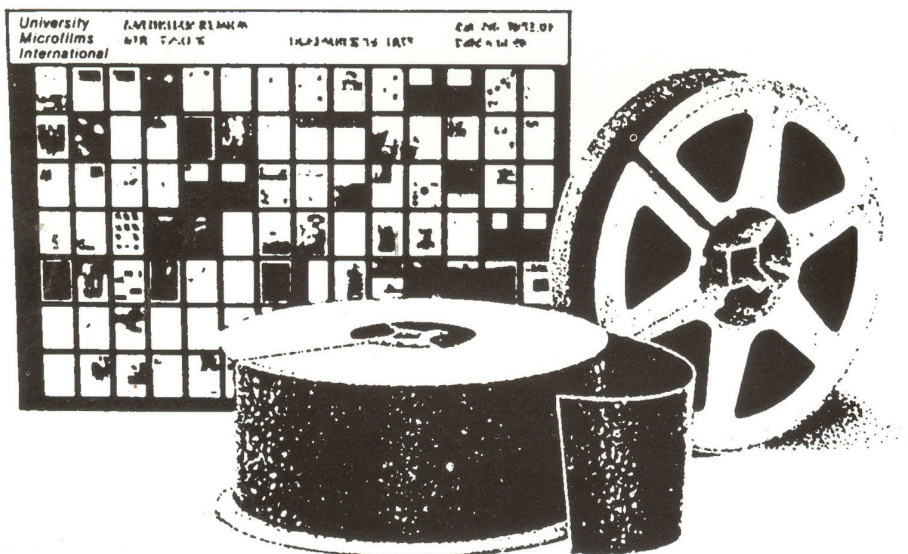
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CONTENTS

EDITORIAL

- An integrated approach to malaria control in Papua New Guinea *M.W. Hetzel* 1

ORIGINAL ARTICLES

- Reference values for pulse oximetry in healthy children in coastal Papua New Guinea *M. Laman, P. Ripa, J.D. Vince and N. Tefuarani* 8
- Predictors of HIV testing and serostatus amongst children admitted to Port Moresby General Hospital *W.E. Allison, M. Kiromat, J.D. Vince, M. Schaefer and J. Kaldor* 13
- Thiamine (vitamin B1) status of boarding school students in the Southern Region of Papua New Guinea *P. Temu, V.J. Temple, A. Saweri and W. Saweri* 21
- Outbreak of nosocomial sepsis in the Special Care Nursery at Port Moresby General Hospital due to multiresistant *Klebsiella pneumoniae*: high impact on mortality *A.E. Lithgow and C. Kilalang* 28
- The role of HIV social research in the response efforts to the HIV epidemic in Papua New Guinea *A. Kelly* 35
- Common themes in the literature on traditional medicine in Papua New Guinea *J. Macfarlane* 44

MEDICAL HISTORY

- Malaria survey and malaria control detachments in the South-West Pacific Area in World War 2 *D.W. Crocker* 54

MEDLARS BIBLIOGRAPHY

69

EDITORIAL

An integrated approach to malaria control in Papua New Guinea

It is to be hoped that this easternmost part of the malarious world will in the not too distant future rid itself of [malaria] which...is a hostile power in many of the villages.

Robert H. Black, 1974

The optimism reflected in Robert Black's editorial in the *Papua New Guinea Medical Journal* 35 years ago (1) gives reason to reflect about the progress of malaria control in Papua New Guinea (PNG). Has PNG come any closer to the ambitious goal of ridding itself of malaria since the time that editorial was written?

Malaria in Papua New Guinea

According to recent figures, PNG has the highest rates of malaria morbidity and mortality outside the African continent. Official statistics reported approximately 1.5 million clinical episodes and 2800 malaria-attributed deaths in 2006. Over 60% of the estimated population of 6.2 million live in areas where malaria transmission is endemic (2). Endemicity ranges from holoendemic transmission in some areas of the coastal lowlands and islands to unstable transmission with localized epidemics at altitudes between 1300 and 1600 m to no transmission above 1700 m (3).

All four of the principal human malaria species are endemic in PNG. *Plasmodium falciparum* and *P. vivax* are encountered most frequently and both species have been associated with severe disease in children (4). The mosquitoes of the *Anopheles punctulatus* group are the principal malaria vectors but several other species are also abundant. Their ecology and transmission potential differ considerably, contributing to marked small-area variations in the epidemiology of malaria (5,6).

The epidemiology of malaria in PNG has been influenced in different ways by malaria control interventions. Past changes in control

strategies have in some areas led to an increased malaria burden due to complex interactions between control activities and the transmission of different malaria species (7). While efficacious control interventions have the potential to significantly reduce the malaria burden, devastating consequences are often faced when intensive control programs are stopped or break down on managerial, administrative or financial grounds (8,9).

History of malaria control

The first attempts to control malaria in selected areas of PNG started after World War 2 with the use of medicines, mosquito nets, drainage of swamps (such as parts of the Wahgi Valley), larviciding and residual spraying with insecticides. Yet it was not until 1957 that a pilot project in the Maprik area laid the foundation for an eradication campaign based largely on indoor residual house spraying (IRS) with dichloro-diphenyl-trichloroethane (DDT) and mass drug administration (10). Although the aim of eradicating malaria from PNG was officially abandoned in 1972, DDT spraying remained a major method of control (11). In 1973, the people in Milne Bay, Northern, Chimbu, East and West New Britain, New Ireland, Manus and Bougainville were reported to be covered 100% with spraying operations (10). The overall goal of this program was to reduce the burden of malaria until it ceased to be an important public health problem in any part of the country. Full national program coverage was planned for 1978 (11). Initially, DDT seemed to reduce anopheline populations, resulting in reduced parasite prevalence in some communities. However, operational challenges to keep up the laborious campaigns soon became apparent (12). In addition, the lack of sensitivity of campaign implementers towards local perceptions of IRS had led to resistance of villagers towards the spraying campaigns (13). Therefore, the 1974 National Health Plan proposed a better integration of malaria control with other health services and measures to improve community

collaboration and participation (11). Following a major review of the malaria control program in 1983, IRS was stopped and the responsibility for all control operations was transferred to the provinces (12).

It was during this time that the PNG Institute of Medical Research (IMR) conducted one of the first trials demonstrating the health impact of treating mosquito nets with insecticide. The study, done in 1985 near Madang, showed a reduction of *P. falciparum* incidence and prevalence in children below five years of age sleeping under permethrin-treated nets (14). Additional research in the Wosera area demonstrated that mosquito nets (even if not treated) protected not only the individuals using them, but also those living nearby (15). The protective effect of insecticide-treated nets (ITNs) was confirmed in many other trials around the world (16). As a consequence of such findings, the national malaria control program started emphasizing the use of ITNs in 1989. However, no regular or large-scale distribution of ITNs was carried out (17). In the following years, coverage with mosquito nets and other control interventions remained patchy and low in many parts of PNG (18,19).

At the same time, increasing resistance of malaria parasites to the most commonly used drugs became evident. The first cases of chloroquine-resistant malaria were reported in 1976 (20). This progressed rapidly to widespread resistance of *P. falciparum*, and to a slightly lesser extent *P. vivax*, to chloroquine, amodiaquine and sulphadoxine-pyrimethamine (SP). In studies conducted between 2003 and 2005, even combination regimens of these drugs faced up to 29% resistance of *P. falciparum* (21).

Current control strategy

The 2009-2013 National Malaria Control Programme Strategic Plan emphasizes the following key areas of activity with the broad aim of reducing malaria-related morbidity and mortality: access to confirmed diagnosis and effective treatment for malaria episodes, vector control with ITNs throughout the country and IRS in epidemic-prone areas (highlands), epidemic preparedness and response, behaviour change communication, advocacy and health systems strengthening (22). Since 2004, the Global Fund to Fight

AIDS, Tuberculosis and Malaria (GFATM) has substantially supported malaria control in PNG. The first GFATM malaria grant funded the nationwide free distribution of long-lasting insecticide-treated nets (LLINs) and the expansion of confirmed diagnosis, mainly rapid diagnostic tests (RDTs), in rural health centres and microscopy in facilities with existing laboratories (23). A second grant focusing on the introduction of artemisinin-based combination therapy (ACT) and the continuation of ongoing activities, is about to be disbursed.

Evidence of the effectiveness of these key interventions has largely been generated within Papua New Guinea (24). Prompt access to effective malaria treatment is essential in order to prevent progression to severe disease or death. Artemether-lumefantrine is currently the most efficacious ACT that has been tested in PNG. The results of a trial of artemisinin-naphthoquine were not yet publicly available at the time of writing this editorial. If co-formulated, the administration of artemether-lumefantrine is easier than that of other combinations (25). As a result, this drug will be implemented as part of the second GFATM grant. Laboratory diagnosis of malaria allows health workers to treat those who really need it while at the same time enabling them to look for alternative causes of an illness. RDTs are the best alternative to presumptive treatment in places where good quality microscopy cannot be maintained (26).

LLINs are very effective in preventing human-vector contact. The factory-treated nets have the insecticide incorporated into or bound around the net fibres and no re-treatment is required. Re-treatment has always been a major obstacle to the effectiveness of conventional ITNs. One problem was that re-treatment was initially done by health workers rather than the net users and therefore depended heavily on the availability of government funding. Used correctly, LLINs retain their biological activity for three to five years. The impact of mosquito nets can be overwhelming (16), particularly when used in combination with other control measures. In Zanzibar (Tanzania) and South Africa, the combination of nets, IRS and ACT has substantially reduced the malaria burden (27,28). In parts of PNG, the protective effect of increased net coverage is reflected in reduced prevalence of malaria infections (29-31).

Obstacles to coverage and access

Equitable access to and coverage of an intervention, in addition to a high efficacy, are keys to achieving a positive health impact (32,33). The following paragraphs discuss key factors influencing access to health care that are important in the context of PNG. Many of these have also been synthesized in the Health Access Livelihood Framework developed by Obrist et al. (34).

Papua New Guineans access health care from various sources in both the formal sector – health facilities run by the government, churches, non-government organizations (NGOs) or private practitioners, and pharmacies – and the informal sector – community members, traditional healers and drug vendors. The quality of care of different providers varies greatly and formal sources do not always provide the best possible quality of treatment and care. Major obstacles have been identified at health centres and aid posts with regard to staffing, medical supplies and infrastructure (35), resulting in the inability of many facilities to provide essential health services to the population.

Within this context, malaria cases are usually diagnosed presumptively based on clinical signs and symptoms. Laboratories are largely dysfunctional due to a lack of intact equipment, reagents, and skilled laboratory technicians and microscopists. Over-diagnosis of malaria may therefore be a problem (36). Rapid diagnostic tests have been made available but have neither been extensively promoted nor widely used (PNGIMR, unpublished data). Health workers are often in doubt about what to do with negative test results in the presence of fever. Nevertheless, performing the tests is futile if the result is not taken into account (37).

Current standard treatment guidelines recommend amodiaquine or chloroquine + SP as first-line treatment for uncomplicated malaria in children (38). Yet, artemisinin derivatives, currently only recommended for severe malaria, have become increasingly popular for uncomplicated episodes. This is understandable given the high rates of treatment failure with chloroquine + SP (25). However, it is unclear to what extent health workers and patients comply with the dosage regimens of the new drugs which are

recommended to be used over 7 days (38). Widespread use of artemisinin monotherapies (or their use in an inappropriate dosage or in combination with an ineffective partner drug) may lead to the development of resistance against this class of antimalarials (39). The rapid introduction of artemether-lumefantrine as first-line treatment for uncomplicated malaria is the most adequate response to this threat (25). However, the efficacy of the drug may be hampered by poor compliance if health worker training and patient counselling are neglected (33).

Between 2004 and 2007, 1.128 million mosquito nets were distributed nationwide through the GFATM-supported program (Department of Health, personal communication). Rotary Against Malaria (RAM) imported high-quality LLINs which were distributed for free by provincial and district health authorities. At the same time, private and NGO initiatives also gave out nets (partly non-LLIN) to selected communities. While the campaigns rapidly increased the number of nets available in the communities, they also highlighted operational, logistical and managerial challenges. While some villages received fewer nets than required, others were flooded with nets and people did not use them (PNGIMR, unpublished data). Alternative delivery channels, such as health facilities, retailers or immunization campaigns, have either been underutilized or are unavailable in remote areas.

Livelihood aspects, such as the availability of resources at the household level, may also influence whether people receive prevention or treatment for malaria. Social networks, cultural issues, or law and order problems may eventually decide whether mosquito nets are brought to a certain household or whether a sick child reaches a health facility in time (34).

The way forward

In order to achieve maximum health impact, effective interventions need to be combined and optimized to fit the local health system context. In addition, new methods and approaches should be tested and guidelines and policies adjusted quickly if convincing evidence has been generated.

To ensure sustainable high coverage with LLINs, PNG should not focus solely on a

'catch-up' strategy (to quickly achieve high net coverage). Instead, a complementary 'keep-up' strategy should be developed and implemented (40). To achieve this goal, additional net delivery channels to remote communities should be explored, such as engaging the retail sector in selling subsidized nets, combining LLIN distribution with childhood immunization, or distributing nets through aid posts and during antenatal care visits. Re-introduction of IRS is only wise where the required number of spray rounds lies within the capacity of the implementers. Epidemic-prone areas in the highlands require spraying once a year while in areas with year-round malaria transmission, more frequent spraying is necessary. In any case, challenges encountered during earlier spraying campaigns should be taken into consideration. Community concerns related to IRS need to be addressed proactively (13). Operational research should investigate the most cost-effective way of implementing IRS and monitor the resistance of mosquitoes to the insecticides used in IRS and LLINs.

Artemether-lumefantrine had the best efficacy profile in a clinical trial conducted recently in PNG (25). Yet supporting measures are essential in order to translate efficacy into effectiveness at the community level. These include proper health worker training on the new treatment guidelines as well as ongoing supportive supervision of health workers at their duty stations. Artemether-lumefantrine works better against *P. falciparum* than *P. vivax*. Alternative treatment protocols should therefore be tested with the aim to find the best rapid cure against the blood stages as well as liver stages of *P. vivax* (41).

In order to target ACTs and provide proper treatment, malaria case management should encompass confirmed diagnosis. Health care workers need to understand how to use diagnostic tests and also how to interpret the results. Unambiguous guidelines are required for health workers to follow in case a test is negative. To develop these, the tendency of health workers not to rely on laboratory diagnosis or to over-prescribe malaria treatment needs to be explored (42). Experiences from other settings can help in this process. However, findings from areas without vivax malaria need to be interpreted cautiously. Due to the lower sensitivity of currently used RDTs in detecting *P. vivax* parasitaemia (as compared to *P. falciparum*),

false negative results may be more common in areas with high *P. vivax* prevalence (43).

The distance to health services offering good quality of care may decide whether a patient lives or dies. Bringing good quality preventive and curative care to remote communities is key to malaria control. The basis for this is a functioning network of well-run health facilities which are adequately staffed and equipped. Regular supportive supervision is essential to maintain a good quality of care. Home-based management of malaria was encouraged in the 1974-1978 National Health Plan of PNG (11) and is promoted again today by the World Health Organization in order to bring treatment closer to people's homes (44). How such a strategy could be adapted to today's situation in PNG should be explored in an intervention study on a limited scale before attempting large-scale introduction.

A prerequisite for any successful control strategy, however, is that people in affected areas understand what their best options are for the prevention and treatment of malaria. Behaviour change communication, if properly designed and implemented over a long enough period of time, can lead to improved treatment seeking for malaria (33). Combined with training of health workers, community sensitization can make people aware of their ability to actively engage in malaria control.

Most of the critical issues outlined above will be addressed in the GFATM Round 8 Grant which is about to be implemented. However, the main shortcoming of this malaria-focused grant is the failure to engage in an overall renovation of the health system (including infrastructure, human resources and financing, as well as administrative, management and policy issues). Therefore, the success of the GFATM Grant depends to a large extent on initiatives by the National Department of Health and Provincial Governments directed at improving the local health system.

Health systems strengthening

Any health intervention will only be successful if implemented through a strong and well-functioning health system (45,46). Even innovative interventions such as a future malaria vaccine, or intermittent preventive treatment for infants or pregnant

women, cannot be implemented without strengthened national and provincial health systems. To achieve this, the national, provincial and district levels need to join their forces. Involvement of the private sector, churches, missions and NGOs can provide additional benefits as long as their efforts are based on evidence and harmonized with the government's strategies (47,48). Communities should also be included in this effort. They can engage in malaria control at the level of their household, where they can recognize and treat an illness episode quickly, or at the level of the community, where they can facilitate the implementation of control measures. Importantly, community empowerment and involvement can increase accountability within the health system and may eventually lead to better quality of care (35).

If these challenges are addressed with the commitment of all stakeholders and with sustained financial support, efficacious control measures can be translated into a positive health impact. With an adequate investment in monitoring, evaluation and operational research, the necessary evidence for what works and what doesn't can be generated. Once all this is in place, Papua New Guineans may look into the future that Robert Black envisaged in 1974, in which a malaria episode in the family is only an exception and no more the rule.

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Reference values for pulse oximetry in healthy children in coastal Papua New Guinea

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SUMMARY

We expected oxygen saturation (SpO₂) in children in coastal Papua New Guinea (PNG) to be higher than in PNG highlands children. Therefore, SpO₂ was documented to determine the reference values of SpO₂ in neonates and young children; 149 healthy neonates and 100 healthy infants and children <5 years old were studied in Port Moresby. SpO₂ ranged from 93% to 100% in both groups. The median SpO₂ in neonates was 97% (CI 96.9-97.4) and in young children 98% (CI 97.5-98.0). We recommend 93% as the cut-off for administering oxygen to children under 5 years old in coastal PNG.

Introduction

Hypoxaemia increases the risk of death more than four-fold in children with acute lower respiratory tract infection (1). Therefore, the administration of oxygen to hypoxic children is accepted as an important part of management. However, in Papua New Guinea (PNG) purchase and transport costs make oxygen an expensive, scarce and unreliable resource. Its correct use requires a high level of medical and nursing care. Clinical signs have been shown to be poor predictors of hypoxia, and in order to rationalize the use of oxygen, measurement of oxygen saturation by pulse oximetry is being increasingly recommended (2,3). Whilst it is accepted that the level of hypoxia at which oxygen is administered will be largely dependent on its availability, it is also important to know the reference values of oxygen saturation (SpO₂) in Papua New Guinean children.

Studies from different parts of the world have verified that altitude affects SpO₂ values, with lower values occurring at higher altitudes (4-8). At sea level, a study in Chennai showed a mean SpO₂ of 98.5% in children <5 years old (9). The only studies of normal SpO₂ values in PNG children to date were performed at an altitude of 1600 m in Goroka (10,11). A mean SpO₂ of 92%

was regarded as the lower limit of normal in PNG highlands children older than 3 months (10). Since we expected the reference values of SpO₂ in healthy coastal children to be higher than in healthy highlands children, we investigated this by documenting SpO₂ in healthy neonates, infants and children <5 years old residing in coastal PNG.

Method and subjects

This was a prospective observational study of young PNG children in Port Moresby. Healthy neonates born at term were recruited from the Postnatal Ward of Port Moresby General Hospital. Infants and children were recruited from the Children's Outpatient Immunization Clinic of Port Moresby General Hospital and a local kindergarten school. Subjects were carefully screened to ascertain they were representative of healthy coastal PNG children. Inclusion criteria were: age <5 years, residents of coastal PNG, and absence of signs of respiratory or other illness. Children who did not meet these criteria were excluded.

A 515C Novamatrix model pulse oximeter was used in this study. It was standardized every morning prior to its use on study participants by recording the main investigator's SpO₂. After verbal consent, the mother was reassured about the safety of the

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instrument by attaching the oximeter sensor to the investigator's index finger before performing oximetry on her child. A paediatric sensor probe was attached to the child's large toe, and the reading taken after 2 minutes to allow stabilization. The heart rate, respiratory rate and state of wakefulness of the child were also recorded as well as the birthweight for neonates.

The study was approved by the Medical Research Advisory Committee of the Papua New Guinea Department of Health, the School of Medicine and Health Sciences Research Committee and the Port Moresby General Hospital management.

Results

249 subjects were recruited: 149 neonates and 100 infants and children. Their ages ranged from 2 hours old to 5 years old and 51.4% were males.

SpO₂ ranged from 93% to 100% (95% CI 97-98) in both groups with an overall median of 98% (Figure 1, Table 1). The median SpO₂ in neonates was 97% (CI 96.9-97.4) and in young children 98% (CI 97.5-

98.0). The Mann-Whitney U test showed a significant difference between the median SpO₂ of neonates and young children ($p < 0.002$) (Figure 2).

The majority of neonates (70%) were asleep during oximetry. The Mann-Whitney U test comparing SpO₂ in children who were asleep and in those who were awake showed a small difference that was considered significant ($p < 0.04$) (Table 2).

Discussion

As hypothesized, the range of SpO₂ in coastal PNG children was higher than in the PNG highlands, where 92% was recommended as the cut-off for administering oxygen. Our findings are supported by studies in other countries which showed lower SpO₂ values at high altitudes (4-8). At high altitudes, it has been suggested that some of the normal compensatory mechanisms affecting ventilation, cardiac output, pulmonary arterial pressure and vital capacity develop over periods of months to years and are probably not available in young children (12). In PNG, at sea level we found that SpO₂ in children less than 5 years old

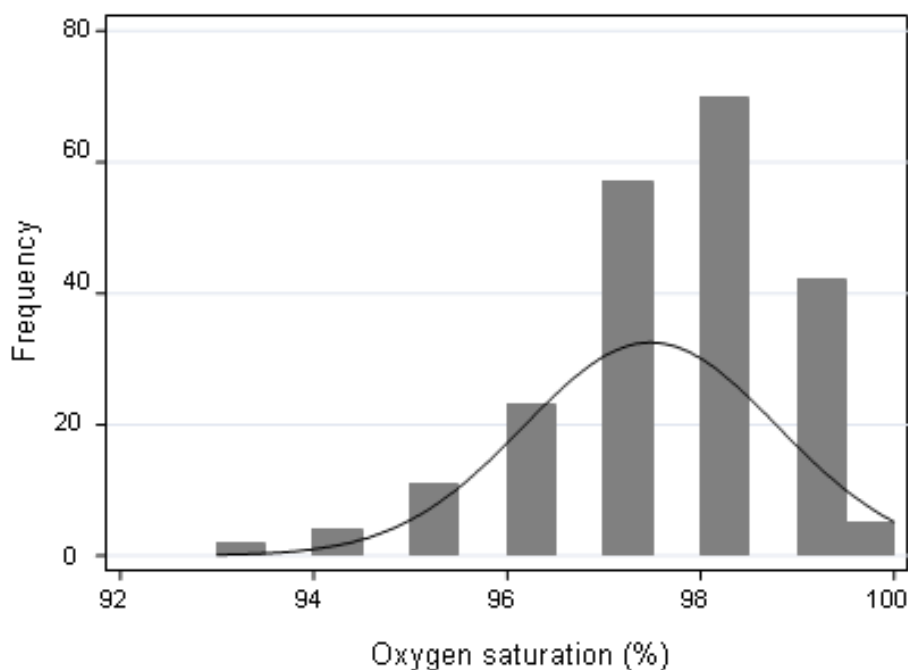


Figure 1. Histogram showing distribution of SpO₂ (oxygen saturation). The line denotes the normal distribution of SpO₂.

TABLE 1

VITAL SIGNS IN HEALTHY NEONATES AND CHILDREN UNDER 5 YEARS OLD

	Range	Median	IQR
Infants and children			
SpO ₂ (%)	93-100	98	97-99
Age (months)	1-60	4	3-6
Respiratory rate (breaths/minute)	28-44	32	30-32
Heart rate (beats/minute)	86-150	126	119-129
Neonates			
SpO ₂ (%)	93-100	97	97-98
Age (hours)	2-168	26	24-31
Birthweight (g)	2000-5050	3000	2900-3090
Respiratory rate (breaths/minute)	36-68	48	48-52
Heart rate (beats/minute)	96-172	120	117-124

IQR = interquartile range

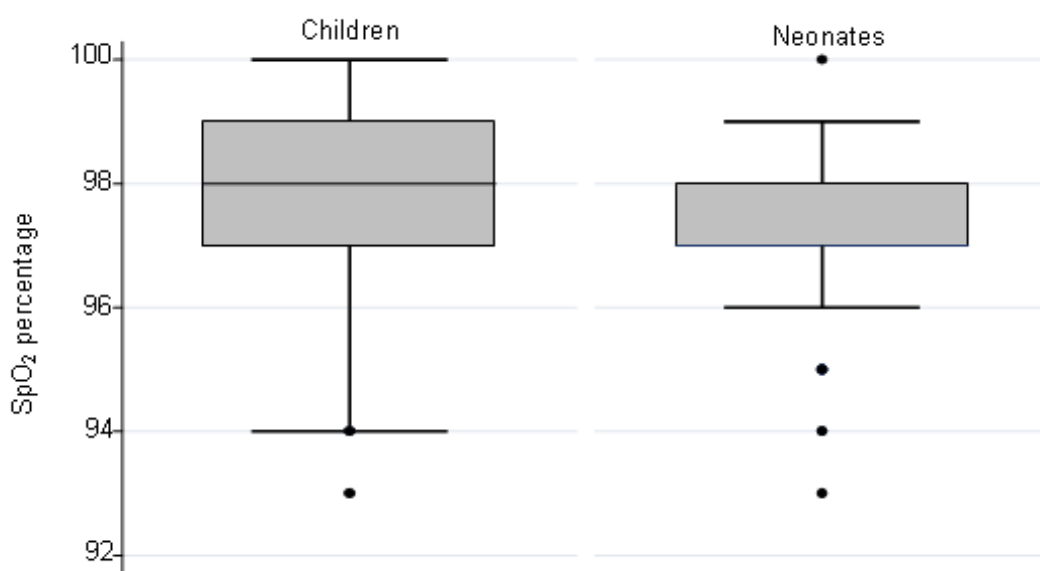
Figure 2. Box plot graph showing comparison of SpO₂ in infants and children versus SpO₂ in neonates.

TABLE 2

STATE OF WAKEFULNESS IN THE CHILDREN STUDIED

	Sleeping	Median SpO₂ %	Not sleeping	Median SpO₂ %	p value
Neonates	104	97	45	97	<0.9
Non-neonates	33	98	67	98	<0.4
Total	137	97	112	98	<0.04

ranged from 93% to 100% with an overall median of 98%. Therefore, we propose 93% as the cut-off for administering oxygen therapy to coastal PNG children with hypoxaemia. This information can guide health care providers to make decisions on the appropriate use of oxygen, although it is recognized that such decisions will be heavily influenced by the availability of oxygen.

This study also showed that there was a small but significant difference between the median SpO₂ of neonates and children less than 5 years old, with higher values occurring in the older children ($p < 0.002$). This is supported by findings from other studies which showed that older children have higher SpO₂ values than young ones (6,9). Additionally, there was a small but significant difference between children who were asleep and those who were awake ($p < 0.04$). This finding is also supported by the study performed in the highlands of PNG (10). However, the levels of difference shown are too small to be of clinical relevance.

Pulse oximetry is simple to use, rapid and non-invasive. Several studies have described clinical signs such as increased respiratory rate, grunting, tachypnoea, head nodding and cyanosis as predictive of hypoxaemia. However, these individual signs and their combination have low predictive power (1,2,13-15). Therefore, assessment of SpO₂ by pulse oximetry is superior in diagnosing hypoxaemia and is often considered in paediatrics as the fifth vital sign (16). The reference values from this study reinforce our recommendation (2) that protocols based on pulse oximetry should be used to correctly identify hypoxic

children and to rationalize the use of oxygen in PNG.

In neonates it has been shown that pulse oximetry screening promotes early detection of congenital heart disease and other potentially severe diseases (17). But it has been documented that pulse oximetry is unreliable when subjects are experiencing hypothermia, hypovolaemia and shock. Wearing of nail polish, direct sunlight and certain dyes may also interfere with SpO₂ readings (18). However, based on our screening criteria, we believe our study participants were representative of healthy coastal PNG children.

This study adds to the two previous studies that have derived reference ranges of SpO₂ in well children in the highlands of PNG (10,11). We now have enough information on SpO₂ in the two contrasting settings in PNG, high altitude and sea level. The information from these studies can now provide adequate reference values of SpO₂ and thresholds for administering oxygen in all regions of PNG where oxygen therapy is available.

ACKNOWLEDGEMENT

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Predictors of HIV testing and serostatus amongst children admitted to Port Moresby General Hospital

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SUMMARY

The aim of this study was to identify factors associated with current HIV (human immunodeficiency virus) testing practice at Port Moresby General Hospital and positive serostatus among children tested, as a basis for contributing to guidelines on HIV testing for children in Papua New Guinea. Data were extracted from hospital records to determine the demographic and presenting clinical characteristics of admitted children tested for HIV serostatus between 1 December 2005 and 30 November 2006. These data were compared with corresponding data from untested control children from the same wards. The same characteristics were compared between seropositive and seronegative cases. Odds ratios were derived for potential predictors of testing and its outcome. During the study period, HIV tests were reported on 215 children, of whom 57 were seropositive. Controls were 264 untested children. Tested children were more likely to be aged 18 months or less, to have been admitted for more than 7 days, and to have diarrhoea, be malnourished or have oral candidiasis. Among children tested, suspected tuberculosis as a presenting illness was significantly predictive of HIV-positive serostatus. This study indicates that certain clinical factors associated with HIV-positive status in children may not yet have been incorporated into testing practice, and underlines the importance of developing a systematic approach to testing children for HIV in Papua New Guinea.

Introduction

Early diagnosis of HIV (human immunodeficiency virus) infection in children is important as it provides the pathway to appropriate care, treatment and support, potentially reducing morbidity and mortality as well as providing a starting point for identifying other family members who may have HIV infection. Although there are well-established clinical and laboratory algorithms for diagnosing paediatric HIV infection (1-3) they can present challenges in the resource-

limited settings where most children with HIV infection live. There are particular technical difficulties for children less than 18 months old, in whom maternal HIV antibodies may still be present even if the child is not infected with the virus (1).

A number of clinical signs and symptoms are common both in children infected with HIV and in children with other conditions, particularly in resource-limited settings (4-7). Where the hospital prevalence of HIV infection is very high, such as in some African

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countries, an argument can be made for testing all admitted children for HIV serostatus. However, in settings such as Papua New Guinea (PNG), where prevalence is relatively low (8), clinicians must decide which children to select for testing on the basis of clinical criteria.

PNG has the highest prevalence of HIV infection in the Asia-Pacific region with an estimated national prevalence of 2.03% for 2007 in a population of approximately six million people (9). Port Moresby General Hospital (PMGH) is a tertiary referral hospital situated in Port Moresby, the capital of PNG, and is the largest health facility in the country. Paediatric services at the hospital consist of a special care nursery, catering for 1000 neonates per year, 2 wards with a total of 120 beds admitting approximately 5000 children per year, a consultation clinic and a children's outpatient department. Children with HIV infection have been cared for at PMGH since the beginning of the HIV epidemic in PNG, with antiretroviral therapy for children becoming available in 2005.

As a basis for contributing to guidelines on HIV testing for children in Papua New Guinea, a retrospective study of HIV testing and its outcome in children admitted to PMGH was undertaken. The objectives were to identify factors associated with testing for HIV serostatus and HIV positivity amongst those tested.

Methods

The study population comprised all children (aged 0-11 years) admitted to PMGH who had been tested for HIV antibodies between 1 December 2005 and 30 November 2006 and a control series of children admitted during the same time period who had not been tested. Predictors of HIV testing were ascertained using a case-control approach and predictors of HIV positivity were ascertained from within the group of children who had been tested.

A list of admitted children who had been tested for HIV infection during the study period was obtained from the hospital laboratory. The children on the list were identified in the ward admission book which documents the name, sex, age, province of origin, residence, date of admission, admission diagnosis, discharge diagnosis, and date of discharge, abscondment or death

of each child admitted to each of the two paediatric wards. The control group of children, who had not been tested for HIV infection, was obtained by selecting every 10th child in the ward admission book within the specified time period, omitting those who had been tested. For each tested and control child, the full clinical record was sought from the medical records department to obtain further information, including date of birth, admission weight, details of the presenting illness, whether the subject had had a previous HIV antibody test and mother's HIV status. From this information two data sets were derived:

Predictors of testing data set – only data obtained from the children's available clinical records were used to compare characteristics of tested and non-tested children.

Predictors of HIV test positivity data set – a larger data set, using data not only from available clinical records but also from the ward admission book records, was used to compare the characteristics of children testing positive with those of children testing negative.

Analyses were carried out using the statistical software package SPSS version 15. Comparisons between groups were assessed using a chi squared test or Fisher exact test if the sample size was small. Statistical significance was defined as a p value of <0.05. Association was analysed by calculation of odds ratios and 95% confidence intervals comparing tested children with untested children and antibody-positive children with antibody-negative children.

Permission to carry out this study was obtained from the office of the Chief Executive Officer of Port Moresby General Hospital and ethical approval was also obtained from the University of New South Wales Human Research Ethics Committee, Sydney, Australia.

Results

Between 1 December 2005 and 30 November 2006 a total of 5187 children aged less than 11 years were recorded in the ward record books as having been admitted to PMGH. A total of 215 children were tested for HIV antibodies over the same 12-month

period representing 4% of the total admissions. Of children tested, 57 were found to be positive for HIV antibodies, representing 27% of children tested. There were 264 children selected as controls, bringing the final number of children for whom clinical information was retrospectively sought to 479.

Figure 1 illustrates the sources of the data sets.

Predictors of testing

Clinical records were available for 95 of the 215 children recorded as tested. Data from these records were compared with those from the 214 available records of the selected non-tested control children. The results are shown in Tables 1 and 2. Tested children were significantly more likely to be

aged 18 months or less, admitted for more than 7 days, and to have diarrhoea, malnutrition or oral candidiasis.

Predictors of HIV positivity

Combined data from clinical records and the ward admission book were available for 171 tested children and the comparison between those children testing positive and negative is shown in Tables 3 and 4. There was no difference between positive and negative children with respect to age, residence or length of stay in hospital (Table 3). Suspected tuberculosis (TB) as a presenting illness was the only condition found to be significantly predictive of positive serostatus (Table 4). Oral candidiasis and pneumonia were more frequent conditions in HIV-positive children, but not significantly so.

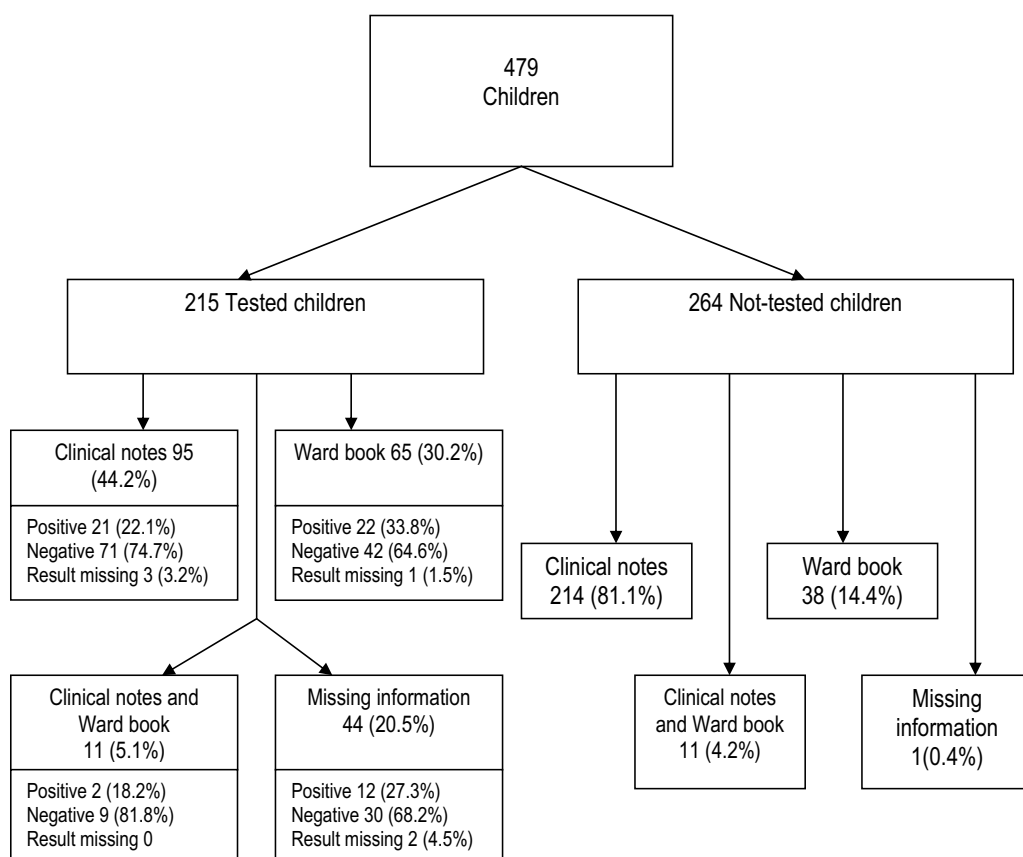


Figure 1. Sources of information on children tested and not-tested for HIV.

TABLE 1

COMPARISON OF TESTED AND NOT-TESTED CHILDREN BY AGE, RESIDENCE AND LENGTH OF HOSPITAL STAY

	Tested	Not-tested	p value	Odds ratio (95% confidence interval)
Age (months)	*N = 94 (%)	*N = 213 (%)		
0-18	70 (74.5)	126 (59.2)	0.010	2.01 (1.18 - 3.45)
≥19	24 (25.5)	87 (40.8)		
Residence	*N = 92 (%)	*N = 209 (%)		
Port Moresby/NCD	78 (84.8)	179 (85.6)	0.845	0.93 (0.47 - 1.86)
Other	14 (15.2)	30 (14.4)		
Length of stay (days)	*N = 87 (%)	*N = 212 (%)		
0-7	23 (26.4)	147 (69.3)	0.0005	0.16 (0.09 - 0.28)
≥8	64 (73.6)	65 (30.7)		

*Variation in number due to missing data within clinical notes obtained (refer to Figure 1)

NCD = National Capital District

Discussion

This retrospective study represents the first attempt to evaluate HIV testing practice in children in Papua New Guinea and to identify demographic and clinical factors associated with testing and with positive HIV serostatus in those tested. There were several limitations. Non-availability of clinical case records was a significant problem, with only 95/215 (44%) of records from tested children being available. In addition, there were large variations in the level of detail in the clinical record, dependent as it was on the individual clinician's practice, which further contributed to missing data. Tracing records of children tested was hampered by the inconsistent use of medical record numbers for laboratory identification. Children with multiple admissions were sometimes registered as different individuals, leading to two or three sets of clinical notes that were not necessarily stored in the same place. In spite of these limitations, the study proved informative.

Our results indicated that the threshold for testing children for HIV at that time was high. The recorded prevalence of HIV infection

among 3514 pregnant women attending the antenatal clinic at PMGH in 2006 was 1% (9). With only 4% of the approximately 5000 paediatric admissions per year being tested, it is a reasonable assumption that seropositive children were presenting to hospital and not being tested.

Clinicians were more likely to test children who were under 18 months old and it is encouraging that despite the lack of a definitive test being available for this age group, they were not deterred from undertaking testing – nucleic acid testing became available at PMGH in 2008 but is currently still not widely available throughout PNG. Children who had been in hospital for longer than 7 days were more likely to be tested, indicating a tendency for clinicians to think of HIV infection as a possibility in sicker children.

Our retrospective assessment of clinical records found that a very small proportion of admitted children at PMGH were tested for HIV antibodies at that time, and that the clinical indicators that led to testing were not generally strong predictors of HIV infection. Children with diarrhoea, malnutrition and oral

TABLE 2

COMPARISON OF TESTED AND NOT-TESTED CHILDREN BY PRESENTING ILLNESS

Presenting illness	Tested *N = 93 (%)	Not-tested *N = 214 (%)	p value	Odds ratio (95% confidence interval)
Diarrhoea	54 (58.1)	96 (44.9)	0.033	1.70 (1.04 - 2.78)
Vomiting	18 (19.4)	45 (21.0)	0.739	0.90 (0.49 - 1.67)
Malnutrition	24 (25.8)	29 (13.6)	0.009	2.22 (1.21 - 4.07)
Lymphadenopathy	3 (3.2)	8 (3.7)	1.000	0.86 (0.22 - 3.31)
Tuberculosis	5 (5.4)	17 (7.9)	0.423	0.66 (0.24 - 1.84)
Fever	41 (44.1)	118 (55.1)	0.075	0.64 (0.39 - 1.05)
Cough	40 (43.0)	85 (39.7)	0.590	1.15 (0.70 - 1.88)
Shortness of breath	10 (10.8)	46 (21.5)	0.025	0.44 (0.21 - 0.92)
Pneumonia	2 (2.2)	9 (4.2)	0.373	0.50 (0.11 - 2.36)
Oral candidiasis	15 (16.1)	1 (0.5)	0.0005	40.96 (5.32 - 315.27)
Abdominal signs ^a	4 (4.3)	15 (7.0)	0.365	0.60 (0.19 - 1.85)
Night sweats	2 (2.2)	9 (4.2)	0.373	0.50 (0.11 - 2.36)
Seizures	1 (1.1)	14 (6.5)	0.045	0.16 (0.02 - 1.20)
Abscess	1 (1.1)	2 (0.9)	1.000	1.15 (0.10 - 12.87)
Headache	1 (1.1)	4 (1.9)	1.000	0.57 (0.06 - 5.18)
Ear discharge	2 (2.2)	1 (0.5)	0.219	4.68 (0.42 - 52.28)
Jaundice	1 (1.1)	2 (0.9)	1.000	1.15 (0.10 - 12.87)
Other	5 (5.4)	20 (9.3)	0.243	0.55 (0.20 - 1.52)

^aPain, swelling, distension

*Variation from total numbers of tested and not-tested children due to missing data within clinical notes obtained (refer to Figure 1)

candidiasis were likely to be selected for testing, but diarrhoea and malnutrition together account for a high proportion of admissions to the ward and are significant causes of both morbidity and mortality (10). Oral candidiasis is less common but is well known to be HIV related and clearly raises the possibility of HIV infection in the minds of clinicians.

The most accurate data obtained from clinical notes were used in the comparison of tested and untested children. When the same analysis was carried out using combined data from both the clinical notes and the ward record book similar results were obtained showing that children with malnutrition and oral candidiasis but not diarrhoea were likely to be selected for

TABLE 3

COMPARISON OF POSITIVE AND NEGATIVE CHILDREN BY AGE, RESIDENCE AND LENGTH OF HOSPITAL STAY

	HIV Positive	HIV Negative	p value	Odds ratio (95% confidence interval)
Age (months)	*N = 45 (%)	*N = 122 (%)		
0-18	33 (73.3)	94 (77.0)	0.618	0.82 (0.37 - 1.79)
≥19	12 (26.7)	28 (23.0)		
Residence	*N = 45 (%)	*N = 118 (%)		
Port Moresby/NCD	36 (80)	105 (89.0)	0.133	0.50 (0.20 - 1.26)
Other	9 (20)	13 (11.0)		
Length of stay (days)	*N = 36 (%)	*N = 114 (%)		
0-7	7 (19.4)	31 (27.2)	0.351	0.65 (0.27 - 1.63)
≥8	29 (80.6)	83 (72.8)		

*Variation in number due to missing data (refer to Figure 1)

NCD = National Capital District

testing. Whilst it would have been ideal to use only the clinical records for comparison of the positive and negative children the relatively small numbers in each group meant that it was necessary to use the less accurate information from the combination of clinical notes and the ward record book for this analysis.

Suspected TB was the only clinical condition that was predictive of HIV seropositivity though it appears not to be one of the conditions that increased the suspicion of HIV infection among clinicians and was not found to be predictive of testing. The impact of HIV infection on tuberculosis in children in resource-limited settings is well documented though (5,11-14) and supports our findings. However, there must be some caution in comparing the two separate analyses of tested versus untested (Tables 1 and 2) and positive versus negative children (Tables 3 and 4) as the differences in missing data limit the accuracy of the comparison.

The availability of antiretroviral therapy,

cotrimoxazole prophylaxis and other effective treatments should encourage health workers in resource-limited settings to request more testing. Our study suggests that child health workers in Papua New Guinea are very probably underestimating the impact of HIV. HIV testing in children in Papua New Guinea needs to be increased and there is a need for prevalence studies in sick children in different settings to inform practice.

The identification of HIV-positive children using the currently established clinical criteria remains difficult. The World Health Organization clinical case definitions which are used in resource-limited settings have only been evaluated in African children, most recently in South Africa (4,15). In countries with high infant mortality where malnutrition and TB are endemic, such as Papua New Guinea, it is likely that clinical markers of HIV in young children will lack specificity. There is a need to prospectively evaluate the effectiveness of these case definitions in settings such as Papua New Guinea where the prevalence of HIV infection, whilst lower than in sub-Saharan Africa, is significant and

TABLE 4

COMPARISON OF POSITIVE AND NEGATIVE CHILDREN BY PRESENTING ILLNESS

Presenting illness	HIV Positive *N = 44 (%)	HIV Negative *N = 121 (%)	p value	Odds ratio (95% confidence interval)
Diarrhoea	20 (45.5)	64 (52.1)	0.453	0.77 (0.38 - 1.53)
Vomiting	7 (15.9)	32 (26.4)	0.159	0.53 (0.21 - 1.30)
Malnutrition	9 (20.5)	33 (27.3)	0.374	0.69 (0.30 - 1.58)
Lymphadenopathy	2 (4.5)	2 (1.7)	0.285	2.83 (0.39 - 20.75)
Tuberculosis	10 (22.7)	10 (8.3)	0.012	3.27 (1.25 - 8.50)
Fever	5 (11.4)	34 (28.1)	0.025	0.33 (0.12 - 0.90)
Cough	9 (20.5)	28 (23.1)	0.715	0.85 (0.37 - 1.99)
Shortness of breath	2 (4.5)	7 (5.8)	1.000	0.78 (0.16 - 3.88)
Pneumonia	9 (20.5)	15 (12.4)	0.194	1.82 (0.73 - 4.53)
Oral candidiasis	5 (11.4)	9 (7.4)	0.424	1.60 (0.50 - 5.05)
Abdominal signs ^a	0 (0.0)	4 (3.3)	0.574	-
Night sweats	1 (2.3)	1 (0.8)	0.453	2.79 (1.17 - 45.6)
Seizures	2 (4.5)	0 (0.0)	0.070	-
Abscess	1 (2.3)	0 (0.0)	0.267	-
Headache	0 (0.0)	1 (0.8)	1.000	-
Ear discharge	0 (0.0)	2 (1.7)	1.000	-
Jaundice	0 (0.0)	1 (0.8)	1.000	-
Other	4 (9.1)	7 (5.8)	0.486	1.63 (0.45 - 5.85)

^aPain, swelling, distension

*Variation in number due to missing data (refer to Figure 1)

rising, but where there is an equal lack of laboratory capacity for definitive diagnostic tests in the paediatric population. Building health research capacity in developing countries and the need for health policy guided by local research is essential in combating not just HIV but a number of tropical infectious diseases that are responsible for significant morbidity and mortality (16-18). Even if definitive diagnostic tests become widely available in a resource-

limited setting, the need for clinical case definitions for HIV infection to identify children at risk and offer them testing will remain, in the absence of a policy of routine HIV testing of all admitted children in a hospital setting.

Our study showed that clinical factors associated with HIV infection may not have been incorporated into testing practice at PMGH and that opportunities for diagnosing and treating infected children and their

parents were almost certainly being missed. Missing data limit the interpretation of the results presented but the outcome has formed a valuable exploratory study. Based on the results of this study, in order to address the problem of missing data, a prospective cross-sectional study to ascertain predictors of HIV infection in children has been planned, with the aim of developing a systematic approach in Papua New Guinea to maximize the selection of admitted children for testing for HIV infection.

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Thiamine (vitamin B1) status of boarding school students in the Southern Region of Papua New Guinea

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SUMMARY

Thiamine pyrophosphate (TPP) is the major biologically active form of thiamine (vitamin B1). This cross-sectional study assessed whole-blood thiamine pyrophosphate concentration (WBTPPC) in boarding school students in the Southern Region of Papua New Guinea. Sample size for each of the five boarding schools was calculated using the 'proportionate to population size' cluster sampling technique. The 'Clin-Rep' reagent kit was used for the extraction of thiamine pyrophosphate from whole blood. Reverse phase high performance liquid chromatography with post-column derivatization was used to determine the thiamine pyrophosphate concentration. Informed consent was obtained from 468 students, mean age 17.7 ± 1.5 years. The gender distribution of these students was 274 (58.5%) males and 194 (41.5%) females. The median and interquartile range of WBTPPC for all students was $95.41 \mu\text{g/l}$ (82.27-113.55). Severe to marginal status of thiamine deficiency was present in 6.4% of all the students. The mean WBTPPC for female students was significantly lower than that for the male students ($p < 0.001$), with a mean difference of $14.17 \mu\text{g/l}$ (95% CI of the difference: 9.85-18.50). Severe to marginal status of thiamine deficiency was present in 9.8% of female students and 4.0% of male students. The data strongly support the need for effective implementation and monitoring of food fortification legislation in Papua New Guinea. Withdrawal of fortification or suboptimal thiamine fortification of rice and other cereal products in Papua New Guinea would have serious negative public health implications, especially among students in boarding schools.

Introduction

Thiamine pyrophosphate (TPP), the major biologically active form of thiamine (vitamin B1), is the coenzyme for oxidative decarboxylation reactions in the mitochondria (1). The daily requirement for thiamine is enhanced by heavy physical exertion, pregnancy, intermittent illness, surgery, reduced absorption of thiamine, persistent high blood alcohol levels, dysentery, diarrhoea, nausea and vomiting (1-4).

Both overt and subclinical (mild to

moderate) thiamine deficiency can severely alter metabolic functions in the nervous, cardiac, respiratory and endocrine systems (1-4). Overt thiamine deficiency (both wet and dry beriberi) is rare, because most countries have implemented food fortification programs (1,2). However, in some developing countries, such as Papua New Guinea (PNG), subclinical thiamine deficiency poses a threat in communities where changes in lifestyle and eating habits have led to high-calorie malnutrition (1,2,5). Subclinical thiamine deficiency has been reported in communities where the diet

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contains polished rice as staple food, a high consumption of carbonated drinks and confectionery, betelnuts, and raw fermented fish containing high levels of anti-thiamine factors (1-4).

According to World Health Organization (WHO) criteria, a single case of properly diagnosed clinical thiamine deficiency in a population reflects a public health problem and calls for a full nutritional assessment using appropriate biochemical methods to assess the thiamine status of the population (1,2).

The criteria for assessment of thiamine status of individuals depend on the assay procedure used (1,2,6-8). The direct measurement of TPP in either erythrocytes or whole blood by high performance liquid chromatography (HPLC) is the currently recommended technique for assessment of thiamine status of individuals (6-9). This assay procedure has clear advantages over others in terms of sensitivity, reproducibility, specificity, precision and robustness (6-9). According to the recommended cut-off points, a TPP concentration below 50.85 µg/l indicates severe thiamine deficiency, whereas a TPP concentration between 50.85 and 63.56 µg/l indicates marginal thiamine deficiency (1,2,6,8,9). Several authors (6-9) have reported that it is more convenient to use whole blood for assay of TPP, because the preparation of washed erythrocytes is time-consuming and has safety implications, and accidental damage to the erythrocytes can cause loss of TPP. According to Talwar et al. (6), measurement of TPP in erythrocytes by HPLC correlated strongly with that in whole blood ($r = 0.97$).

A search of the published literature indicates that in PNG there has been little or no scientific study conducted to assess the thiamine status of the population (10-12). There are anecdotal reports of beriberi in the late 1950s and early 1960s in PNG (10,11). In order to prevent the incidence of micronutrient deficiencies in the population, the PNG government passed legislation banning the importation and sale of foodstuffs that are not appropriately fortified with micronutrients (13-16). According to the Pure Food Act, white rice fortified with thiamine, niacin and iron to approved levels should be sold in PNG (13-16). In 2005, the 'Rice development policy' was approved and implemented in PNG (15). The aim of this

policy was to encourage local rice production among subsistence farmers, and to help boarding schools and correctional institutions become self-sufficient by producing local rice. Locally grown rice is also subject to the PNG food standards, as indicated in the Pure Food Act (14).

While there are food fortification legislation and regulations in place that require fortification of various foodstuffs with micronutrients, there is paucity of published data for assessing the implementation of the fortification policy in PNG. In addition, published data on the assessment of the impact and effectiveness of the fortification on target communities in PNG is scanty.

This study was prompted by the apparent lack of scientific data on the thiamine status of the population in the Southern Region of PNG.

The aim of this study was to assess the thiamine status of students in boarding schools in the Southern Region of PNG. Selection of boarding school students was based on their high vulnerability to low thiamine intake, easy accessibility, and representativeness of their age group in communities in PNG.

Subjects and Methods

Study sites

This study was carried out in the Southern Region of PNG. 5 boarding schools were selected based on easy accessibility by road, as blood samples needed to be kept at approximately +4°C in the field and during transportation from the site of collection to the Micronutrient Laboratory (MNL) in the School of Medicine and Health Sciences (SMHS), University of Papua New Guinea (UPNG), for proper storage and analysis.

Sample size

Calculation of sample size was based on a design effect of three, a relative precision of 10% and a confidence level of 95%. As there was no available information on the likely prevalence rate of thiamine deficiency in PNG, an assumed prevalence rate of 25% was used. Thus, the sample size of about 500 boarding students from the boarding schools with a total residential boarding population of 1337 students was considered

sufficient for a study, with a predicted non-response rate of 20% (17).

Study design and sampling

This was a cross-sectional study using a multistage cluster sampling method for selecting the study population. The total enrolment figures for each of the selected boarding schools were obtained from the appropriate authorities in the education departments in the Southern Region of PNG (18). The enrolment figures for students in each of the classes in each boarding school were also obtained (18). The sample size for each school was calculated using the 'proportionate to population size' (PPS) cluster sampling technique (17). Each of the students in the selected boarding schools was assigned a computer-generated number and the required number of students from each school was then selected by simple random sampling, using the randomly generated number list.

All the students were between the ages of 14 and 22 years, and had been living in the boarding houses of the respective schools for at least 4 weeks before sample collection.

Collection of blood samples

About 0.5 ml of blood was collected from each student, by finger-stick, using a contact-activated single-use lancet. The blood was collected into a properly labelled EDTA-coated microtainer. Each blood sample was then kept in a cool box, protected from light and kept at 4-10°C in the field and during transport from the field to the MNL in SMHS, UPNG. All blood samples were stored frozen at -70°C until required for analysis.

Sample analysis and quality control

The 'Clin-Rep' reagent kit was used for the extraction of thiamine pyrophosphate from whole blood (9). All reagents used were of analytical grade and were components of the 'Clin-Rep' HPLC complete kit for assay of TPP (9). The concentration of TPP was measured using a reverse phase high performance liquid chromatography with post-column derivatization (6-9). The excitation and emission wavelengths of the HPLC detector were 376 nm and 435 nm, respectively (6-9). The HPLC operating system used in this study was the Waters Empower 2.0 software, configured for

analysis of TPP in whole blood (9,19).

For internal bench quality control (QC) 'Levy-Jennings' charts for low and high TPP concentrations were prepared, and the 'Westgard' rules were used for daily monitoring of the HPLC output data throughout the period of analysis. The intra-assay coefficients of variation (CV) for the low (52.6 µg/l) and high (106.0 µg/l) concentrations were 6.6% and 4.9%, respectively. The percent recovery of TPP was $95 \pm 5\%$.

Data analysis

Analysis of data was carried out using the Statistics Package for Social Sciences (SPSS) Version 11 for Windows. The Mann-Whitney U test, chi-squared test and t-test were used as appropriate.

Ethical clearance

Ethical clearance for this project was obtained from the Ethical and Research Grant Committee in the SMHS, UPNG, and the Medical Research Advisory Committee (MRAC), National Department of Health (MRAC No. 05/12). Permission was obtained (as required by the PNG Principal Policy Adviser of the National Health Department) from the Provincial Education Boards and the respective heads of each boarding high school. Signed informed consent was obtained from each consenting student. Blood samples were collected only from those students who returned their signed consent forms.

Results

Informed consent was obtained from 468 students (response rate 84.3%). This gives a non-response rate of 15.7%, which was lower than the predicted 20% rate used in calculating the sample size. The mean \pm standard deviation of age of all the students was 17.7 ± 1.5 years, the 95% confidence interval (CI) was 17.6-17.8 years, and the range was 14-22 years.

The gender distribution of the 468 students was 274 (58.5%) males and 194 (41.5%) females. The mean age of the male students was 17.9 ± 1.5 years (95% CI: 17.6 – 18.0), and the age range was 14-22 years. For the female students, the mean age was 17.4 ± 1.4 years (95% CI: 17.2-17.6) and the age

range was 14-21 years. There was no statistically significant difference between the mean ages of the male and female students ($p = 0.43$).

The Shapiro-Wilk test indicated that the distribution curve of the whole-blood thiamine pyrophosphate concentrations (WBTPPC) for the combined study group was not normal ($p < 0.001$; $df = 468$), although it was normal for the males. The box plot presented in Figure 1 shows the presence of several outliers. Table 1 shows the medians and interquartile ranges, the mean and standard deviations, 95% confidence intervals, ranges and 10th centiles of the WBTPPC for all the students and for the males and females separately. The 95% confidence interval for the WBTPPC calculated after log transforming the data was 45.10-145.90 $\mu\text{g/l}$ for all the students and 47.80-152.20 $\mu\text{g/l}$ for the male and 47.76-133.24 $\mu\text{g/l}$ for the female students.

Comparison of the WBTPPC of the male and female students using the Mann-Whitney U test indicates that the values for female students were significantly lower than those for the male students ($p < 0.001$). Further

comparison of the WBTPPC in male and female students, using the t-test for equality of means, indicates a statistically significant difference ($p < 0.001$), with a mean difference of 14.17 $\mu\text{g/l}$ (95% CI of the difference: 9.85-18.50).

The distribution of WBTPPC for all the students, according to the range of WBTPPC and status of thiamine nutrition, is presented in Table 2. Severe to marginal status of thiamine deficiency was present in 6.4% of all the students and was significantly higher in females than in males (9.8% vs 4.0%, $p = 0.001$).

Discussion

In the present study, the WHO-recommended cut-off points for TPP in either erythrocytes or whole blood, assayed by HPLC, were used to assess the thiamine status of the boarding school students (1,2,6,8,9).

Our data indicate 4.0% and 9.8% prevalence of severe to marginal status of thiamine deficiency among the male and female boarding school students,

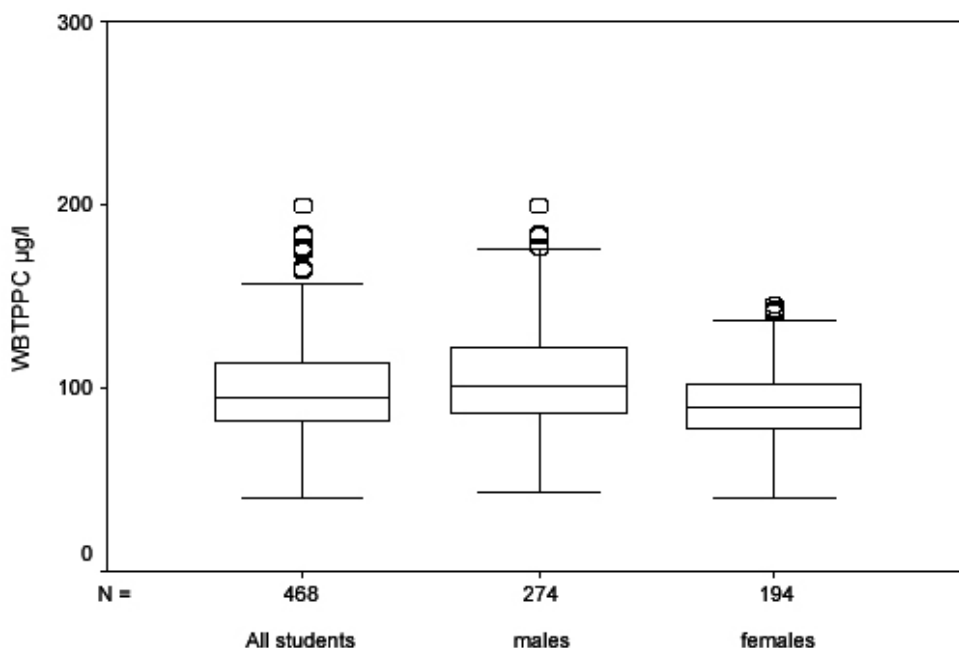


Figure 1. Box plot of whole-blood thiamine pyrophosphate concentrations (WBTPPC) for all students and for male and female students in boarding schools.

TABLE 1

WHOLE-BLOOD THIAMINE PYROSPHOSPHATE CONCENTRATION (WBTPPC) FOR ALL STUDENTS AND FOR MALE AND FEMALE STUDENTS IN BOARDING SCHOOLS

	All students (468)	Male (274)	Female (194)
Median (µg/l)	95.41	101.89	90.01
Interquartile range (µg/l)	82.27-113.55	86.56-121.57	77.45-103.03
Mean (µg/l)	98.80	104.67	90.50
Standard deviation	25.21	26.10	21.37
95% CI (µg/l)	45.10-145.90	47.80-152.20	47.76-133.24
Range (µg/l)	39.62-199.75	42.39-199.75	39.62-145.70
10th centile (µg/l)	69.40	73.16	63.90

TABLE 2

DISTRIBUTION OF WHOLE-BLOOD THIAMINE PYROPHOSPHATE CONCENTRATION (WBTPPC) OF BOARDING SCHOOL STUDENTS ACCORDING TO RANGE OF WBTPPC AND STATUS OF THIAMINE NUTRITION

*Range of WBTPPC (µg/l)	*Status of thiamine nutrition	All students (468)	Male (274)	Female (194)
Percent distribution (N)				
<50.85	Severe deficiency	1.3 (6)	0.4 (1)	2.6 (5)
50.85-63.56	Marginal deficiency	5.1 (24)	3.6 (10)	7.2 (14)
>63.56	Normal status	93.6 (438)	96.0 (263)	90.2 (175)

*Reference 1 and 2

respectively. These values were lower than the 18.2% and 16.6% prevalence of severe to marginal status of thiamine deficiency recently reported among boys and girls in Taiwan (20) and the 22.0% and 32.0% prevalence of low thiamine status reported for boys and girls, respectively, in British schools in the early 1990s (21).

The 10th centile WBTPPC for the male boarding school students (73.16 µg/l) was significantly higher ($p = 0.01$) than the

corresponding value (63.90 µg/l) for the female students. This indicates relatively poor thiamine status among the female compared with the male students. This result contradicts the findings reported by Talwar et al. (6), Shaw et al. (20) and Bovet et al. (22), but supports the findings by Bailey et al. (23).

Some of the factors that can cause low WBTPPC in adolescents and youths include long-term marginal dietary intake of thiamine,

poor dietary choices, reduced energy intake, and/or inappropriate type, duration and intensity of physical exercise (6, 20-22). Thus, the difference in the thiamine status of the male and female boarding school students in our study may be due to a combination of these factors. In addition, although the male and female students in the boarding schools consume meals mainly prepared in the schools, teenage girls tend to 'watch their weight' and may consume less food than their male counterparts, which may lead to inadequate intake of thiamine.

From the public health point of view, our data indicate that a significant number of female boarding school students are at risk of developing marginal thiamine deficiency, because those with a WBTPPC below the 10th centile (63.9 µg/l) are very close to the lower limit of normal (63.56 µg/l). Marginal and severe thiamine deficiency may occur in the event of stress, increased physical activity and increased energy output during exercise, or increased caloric intake without a corresponding increase in the intake of thiamine (2,3,20-22).

There is a need for program planners to ensure that appropriate nutrition and health education, and information and awareness campaigns on the significance of dietary intake of thiamine and other micronutrients are carried out in the various boarding schools in the Southern Region of PNG. Our findings strongly indicate the need for continued effective implementation of the food fortification legislation in PNG.

Conclusions

Our data indicate marginal and severe thiamine deficiency among a significant proportion of students in boarding schools. Females are at greater risk of developing thiamine deficiency than males.

Continued fortification of rice and other cereals with thiamine is strongly recommended. Any change to the current nutrition legislation that would lower the levels of thiamine fortification could significantly increase the prevalence of thiamine deficiency among the high-risk groups in the communities for whom rice and other cereals are staple foods.

Public education and awareness programs outlining the benefits of consuming foods rich

in thiamine and other micronutrients should be carried out in all the boarding schools in PNG.

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Outbreak of nosocomial sepsis in the Special Care Nursery at Port Moresby General Hospital due to multiresistant *Klebsiella pneumoniae*: high impact on mortality

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SUMMARY

We report an outbreak of nosocomial infection caused by *Klebsiella pneumoniae* in the Special Care Nursery of Port Moresby General Hospital. In the 13 months between October 2007 and October 2008, this organism was cultured from the blood of 57 neonates, of whom 23 died. 16 of the 20 organisms cultured in the first 3 months were cephalosporin sensitive, but during the next 10 months the proportion of sensitive organisms dropped dramatically to 10 of 37. Of the 31 multidrug-resistant organisms 6 were resistant to all the routinely available drugs. Response to the outbreak is discussed. The report highlights the urgent need for the implementation of improved infection control practices and the promotion of rational antibiotic policies.

Introduction

Klebsiella is an opportunistic pathogen that primarily targets immunocompromised and hospitalized individuals (1). Nosocomial infection with *Klebsiella pneumoniae* is an important cause of morbidity and mortality for neonates in high-risk nurseries (1). Recent reports of extended-spectrum β -lactamase (ESBL)-producing *Klebsiella pneumoniae* in nurseries have highlighted this problem to paediatricians (2).

The Port Moresby General Hospital (PMGH) is an 850-bed teaching hospital with a 24-bed nursery. There are approximately 11,000 deliveries per year with 1400 newborns admitted to the Special Care Nursery annually.

The Special Care Nursery is a small building located next to the maternity ward, adjacent to the main hospital. It was constructed in 1969 out of fibreboard and, except for a small extension in 1979, it has not been upgraded. It is extremely run-down and lacks basic amenities to accommodate its growing number of patients and their mothers.

A large number of cases of *Klebsiella*

pneumoniae bloodstream infection occurred over 12 months from October 2007. The number of cases peaked in May 2008 with 8 multiresistant infections isolated in blood cultures. Of the 57 neonates from whom the organism was isolated, 23 died. The outbreak prompted analysis of the source and risk factors for infection, and implementation of control measures to contain the outbreak.

Methods

Confirmed cases of *Klebsiella pneumoniae* were identified during the period from October 2007 to October 2008 by review of blood culture results in the laboratory. Clinical and epidemiological data were recorded from clinical charts and data from the Nursery's admission book.

Where possible, information including, but not limited to weight, gestational age, admission source, admission diagnosis, antibiotic therapy and mortality were obtained.

To define overcrowding and understaffing, the nurse-to-patient ratio and level of occupancy were obtained from nursing staff rosters and discussions with staff.

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Observations on infection control practices were made directly, as well as through discussions with the medical staff, trained nurses and community health workers who worked in the Nursery during this period.

Results

57 cases of infection with *Klebsiella pneumoniae* were identified in the 13-month period. Figure 1 shows the number of cases by month. The first positive blood culture for resistant *Klebsiella pneumoniae* was identified on 30 October 2007. During the last 3 months of 2007 there were a large number of patients with a blood culture positive for cephalosporin-sensitive *Klebsiella pneumoniae* (Figure 1). In December, 11 cases of *Klebsiella pneumoniae* were isolated in blood cultures. Only one was a multiresistant strain. There were no cases in January and February. One blood culture positive for multiresistant *Klebsiella pneumoniae* was identified in March. This was followed by an increase in the proportion and number of multiresistant organisms isolated from the Nursery, peaking

in May, when there were 8 multiresistant *Klebsiella pneumoniae* bloodstream infections with 5 resistant to all antibiotics tested.

Comparison of the organisms isolated in 2007 with those in 2008 revealed an increasing proportion of multiresistant isolates in the later year. In 2007, 20% of *Klebsiella* isolates were multiresistant compared to 73% in 2008. 16% of the isolates in 2008 were resistant to all routinely available drugs leaving no treatment options (Figures 2 and 3). Over the whole period, of the 31 multiresistant organisms 6 were resistant to all the available drugs.

The median birthweight of neonates was 1750 g (interquartile range 1458-2730) and the median gestation was 35 weeks (IQR 32-39). The reason for admission documented in 55% of cases was for low birthweight/preterm, in 29% for respiratory distress and in 11% for birth asphyxia. The majority of cases (59%) were admitted directly from the labour ward, 19% from home, 17% from the operating theatre, 4% from a private clinic

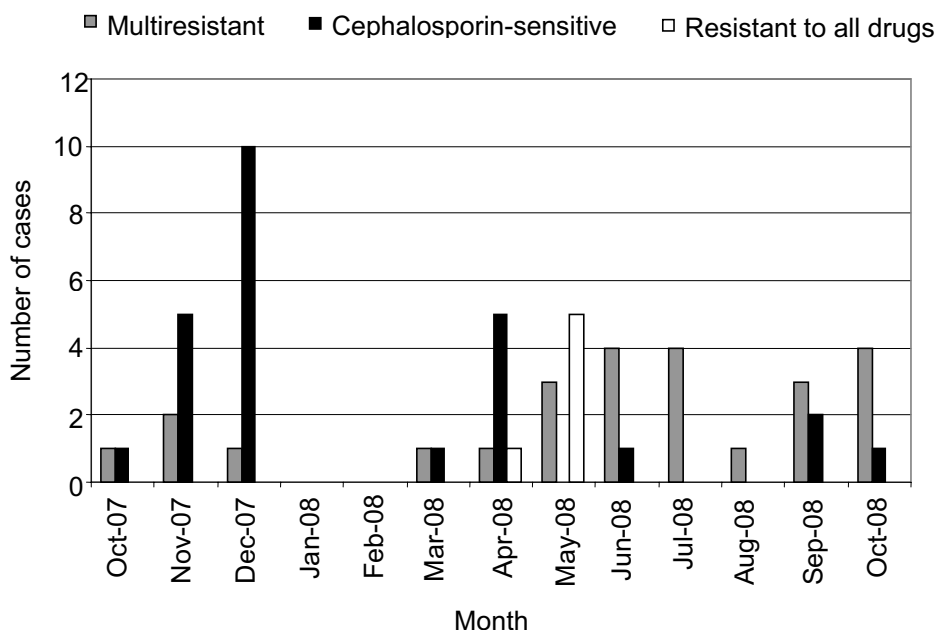


Figure 1. Number of cases of multiresistant and cephalosporin-sensitive *Klebsiella pneumoniae* – October 2007-October 2008.

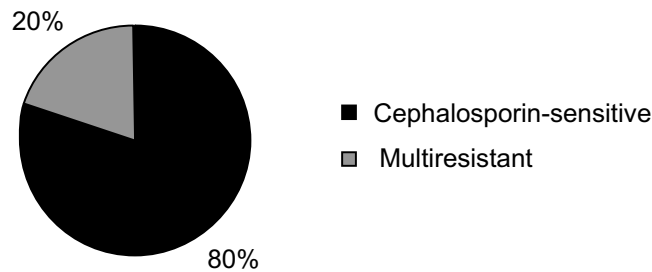


Figure 2. Antibiotic sensitivity patterns of *Klebsiella* isolates, 2007: 16 cephalosporin-sensitive, 4 multiresistant.

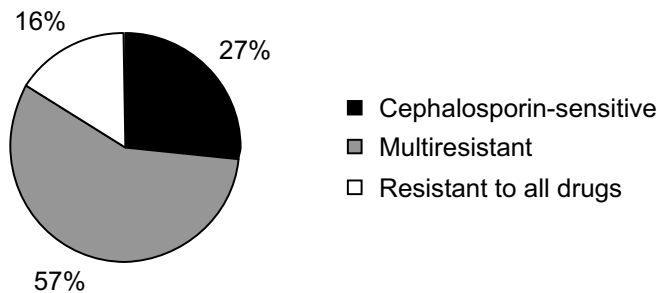


Figure 3. Antibiotic sensitivity patterns of *Klebsiella* isolates, 2008: 10 cephalosporin-sensitive, 21 multiresistant, 6 resistant to all drugs.

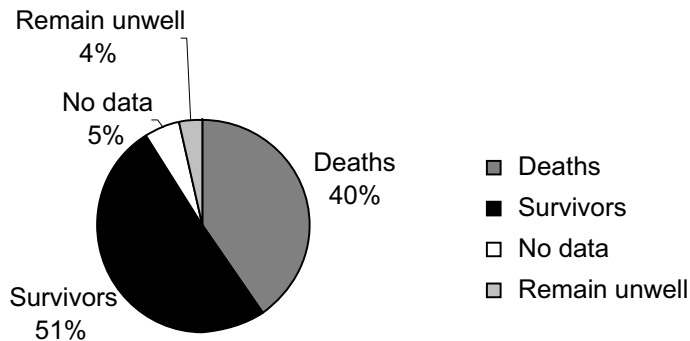


Figure 4. Outcome of *Klebsiella pneumoniae* infection.

TABLE 1

VARIABLES FOR *KLEBSIELLA PNEUMONIAE* BLOODSTREAM INFECTIONS IN THE SPECIAL CARE NURSERY

Variables**Continuous variables: median (IQR)**

Median birthweight, grams	1750 (1458-2730)
Median gestational age, weeks	35 (32-39)
Median day of admission when BC positive	8 (6-11)
Median day of admission when febrile or unwell	3 (1-5)

Categorical variables: number (percentage)

Source:

Labour ward	32 (59.3%)
Theatre	9 (16.7%)
Ward 11	1 (1.9%)
Private hospital/clinic	2 (3.7%)
Home	10 (18.5%)

Primary reason for admission:

Preterm/low birthweight	30 (54.5%)
Respiratory distress	16 (29.1%)
Birth asphyxia	6 (10.9%)
Abdominal distension	3 (5.5%)

Antibiotics on admission*	29 (87.9%)
Blood culture before antibiotics*	4 (12.1%)
Febrile on admission*#	8 (24.2%)
Deaths	23 (40.4%)

*only 33 of the 57 charts could be found for these variables

#or signs of sepsis

IQR = interquartile range

BC = blood culture

and 2% from Ward 11 (Table 1).

The majority of neonates were afebrile on admission to the Nursery (76%). However, most (88%) were commenced on amoxycillin and gentamicin in keeping with the local protocol. Reasons for starting antibiotic therapy included respiratory distress, maternal fever, prolonged rupture of membranes and use of contaminated instruments during home delivery. The median day of admission when the neonates showed signs of sepsis was day 3 (IQR 1-5) and the median day of sampling with a positive blood culture was day 8 (IQR 6-11).

Blood cultures were only taken in 4 patients before commencement of antibiotics and usually were not taken until empirical therapy had failed. Many patients were treated with one or more broad-spectrum antibiotics before directed treatment matching the antimicrobial sensitivity pattern of the *Klebsiella* isolate was given.

23 infected infants died (case fatality rate 40%). 29 neonates (51%) were discharged home; 2 (4%) remained unwell in the Nursery; and the outcome was unknown for 3 patients (5%) (Figure 4).

The current nursery was designed for 24 newborn infants. However, its occupancy varies from 30 to 40. On morning and afternoon shifts, there were 3 nurses for 30 to 40 neonates. There would usually be one registered nurse and two community health workers. This would equate to a nurse-to-patient ratio of 1:10 to 1:13. On a night shift, one registered nurse and one community health worker are rostered on, equating to a nurse-to-patient ratio of 1:15 to 1:20.

Hand washing was not routinely performed between handling of infants. Understaffing and overcrowding as well as lack of facilities, such as paper towels, were identified as barriers to frequent hand washing.

Infection control response

Following the rise in cases in May 2008, the front room of the Nursery, which is occupied by the very low birthweight and clinically unstable patients, was vacated for one day and cleaned by staff. Despite these measures, *Klebsiella pneumoniae* continued to be isolated in blood cultures. The infection control team took swabs from different sites

within the Nursery. Multiresistant *Klebsiella pneumoniae* was identified from a thermometer container, the suction pump, a feeding tube, an intravenous catheter site, the sink and a baby cot as well as the hands of a nursing officer. The front room was then vacated for one week and fumigated. Other infection control responses included restricting the number of visitors to the Nursery.

In mid-October 2008 repeat swabs of multiple sites including the sink, oxygen outlet, intravenous sites and containers holding suction tubing grew multiresistant *Klebsiella pneumoniae*. Further fatal cases of multiresistant *Klebsiella pneumoniae* in September 2008 prompted plans to re-locate neonates to another site so that more extensive decontamination of the Nursery could occur.

A supply of imipenem was obtained at considerable expense to treat subsequent infected babies.

Discussion

The most common habitats of *Klebsiella* are the natural environment and the mucosal surfaces of mammals. Common sites for colonization in humans are the gastrointestinal tract, eyes, respiratory tract and genitourinary tract (1). Once it has been introduced, asymptomatic, colonized patients and/or the hospital environment serve as the reservoir for the organism and rapid spread to other patients can occur via the hands of health care workers.

A number of risk factors have been identified for infection with *Klebsiella pneumoniae*. These include prolonged hospital stay, low birthweight and low gestational age (3). These characteristics were all common in this review. Previous antibiotic therapy is significantly associated with *Klebsiella* infection (4) and local antibiotic policy is a major determinant of the colonization pattern (1). The emergence of ESBL-producing strains has been linked to the use of third-generation cephalosporins, which are used widely as empirical treatment for late-onset sepsis in nurseries (5).

The initial source of *K. pneumoniae* remains unknown. Admission sources include the labour ward, the operating theatre, the postnatal ward, home and a

private hospital. There were cases of multiresistant *K. pneumoniae* in neonates admitted from all of these sites. The presumed source of infection was an infected neonate who subsequently caused cross-infection and colonization of the Nursery environment. It is probable that a large proportion of the gastrointestinal tracts of infants in the Nursery were colonized with *K. pneumoniae*. Despite environmental decontamination procedures, the organism continued to spread between neonates via the contaminated hands of health workers.

Of note, there were many cases of cephalosporin-sensitive *Klebsiella pneumoniae* infection in late 2007, with the proportion of cases due to multiresistant *Klebsiella* increasing in 2008. It is possible that widespread use of broad-spectrum antimicrobials may have selected for emergence of the multiresistant strain. The dearth of cases seen between January and April 2008 may have been due to a decrease in the number of blood cultures taken, coinciding with loss of experienced staff.

In this review, almost all cases were commenced on antibiotics on admission and many infants were treated with multiple broad-spectrum antibiotics before the organism was isolated, commonly in the second week of admission. Blood cultures were not routinely taken on commencement of antibiotics.

Strategies to avoid the overuse of antibiotics in prophylaxis and empirical therapy are necessary. Where possible, blood cultures should be taken on admission before starting antibiotics and a septic screen should be performed when late-onset sepsis is suspected. This would enable clinicians to cease antibiotic therapy after 48 hours if the blood culture is negative and the patient had no signs of sepsis and guide directed antibiotic therapy based on organism susceptibility patterns.

Casolari et al. found a correlation between understaffing and overcrowding with clusters of *Klebsiella* infection (6). In the PMGH nursery, nurse-to-patient ratios have been as low as 1:20 on some shifts. In the United States, guidelines recommend a nurse-to-patient ratio of 1:1 for patients who are unstable and severely ill, 1:2 for patients who are stable but severely ill, and 1:4 for patients who are stable (6). Although these numbers

may be unrealistic in the Papua New Guinean setting, some effort is necessary to address the severe understaffing of nurses and health care workers.

Overcrowding is a major issue. Cots are commonly lined up with no space between them and patients regularly overflow into the nurse's work station area and isolation room. Bed occupancy is up to 170% of its originally designed capacity. From 1995 until 2007, the number of admissions to the Nursery per annum doubled from 700 to 1400. However, there has been no improvement in the quality or size of the facility.

Nursing staff do not routinely wash their hands between patients and have highlighted understaffing and overcrowding as barriers. The lack of adequate facilities is also a significant contributing factor. There are a total of 4 sinks in the Nursery, all with hand-operated taps. Soap dispensers are often empty and hands are usually dried by air or with hanging towels. There is no provision of paper towels or alcohol-based hand wash. In order to curb the spread of *Klebsiella pneumoniae* in the Nursery, there is an urgent need to re-emphasize infection control procedures, especially hand washing, and provide the necessary resources.

A number of studies have demonstrated containment of outbreaks of *K. pneumoniae* infection by cohorting colonized and infected infants (6,7). In Colombia, Richards et al. performed rectal cultures on all 175 infants in the nursery and cohorted patients who were colonized (7). They demonstrated a reduction in prevalence of colonized patients from 61% to 12% among patients admitted after the intervention. This strategy could be considered in our nursery.

Conclusion

Klebsiella are opportunistic pathogens that can spread rapidly and infect a large number of neonates causing significant morbidity and mortality. It is likely that the results of this review are an underestimate of the total number of cases and deaths. We continue to see cases of multidrug-resistant *Klebsiella pneumoniae*, a high proportion of which are resistant to all our routinely available antibiotics. Therefore there is an urgent need for infection control measures that counter the spread of this organism. The following recommendations are made:

- Improvement in nurse-to-patient ratios
- Provision of a new and larger neonatal unit with adequate hygiene facilities
- Improvement in infection control practices, particularly routine hand washing
- Development of an antibiotic policy that promotes rational use of antibiotics
- Implementation of surveillance cultures and cohorting to terminate an outbreak.

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The role of HIV social research in the response efforts to the HIV epidemic in Papua New Guinea

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SUMMARY

The underpinning of social research is that people and communities are social beings. Social research thus offers both qualitative and quantitative ways of measuring, describing, explaining and predicting social life. In this paper I explore the role of this paradigm in addressing the HIV (human immunodeficiency virus) epidemic in Papua New Guinea. Specifically I address the value of social research in its ability to ask different questions in and of the epidemic, to increase understanding of the cultural dimensions of HIV infection, including its treatment, and to respond to the changing needs of communities and individuals as a result of changing applications of HIV technology such as HIV testing, as evidenced by provider-initiated counselling and testing. In conclusion I argue that together in partnership both social and biomedical research and their application have the power to change the way that care is provided for the citizens of Papua New Guinea.

Introduction

Never solely a retrovirus, from the outset, HIV (human immunodeficiency virus) has caused an epidemic imbued with meanings, with definitions and with attributions (1). The HIV epidemic has been amongst other things about sex: specifically who has sex with whom, what they do, how often they do it, where they do it, its connotations, how it is negotiated and if condoms are used. Not just a biomedical problem, HIV infection is a deeply cultural problem. Dennis Altman (2) called it “the most political of diseases”. Because HIV infection is so much more than a disease, we have had to turn to research disciplines other than medicine to understand and respond to this epidemic.

Papua New Guinea (PNG) has the highest HIV prevalence in the Pacific with an estimated prevalence of over 2% of its adult population over the age of 15 years infected with HIV. This paper explores the role of social research and what it can and indeed has offered biomedicine in developing a multidisciplinary response to the HIV

epidemic. Specifically, it focuses on ways in which social research can help us address emergent issues as the epidemic unfolds here in PNG.

Social research and the HIV epidemic

Social research offers both qualitative and quantitative ways of measuring, describing, explaining and predicting social life. Social research thus offers us a way to look at, think about, respond to, monitor and evaluate the local context of the HIV epidemic, and the impact it has on people's lives. It provides evidence about and for the epidemic – its drivers (that is, what causes it to spread above and beyond unprotected sex) and its effects (including but not exclusively mortality). HIV social research has implications for the understanding of epidemiology (for example, who is being infected, who is testing), clinical practice (for example, adherence), health promotion (for example, safe sex) and public health (for example, reductions in HIV transmission).

The best social research understands and

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works from the perspective that all persons and communities are social beings. As HIV moves through time, through communities and villages, along highways and back, and across seas the cultural narratives and explanations of HIV infection change. HIV social researchers are mindful that “the way the epidemic is brought to people’s attention will be [a] critical determinant of how they will respond to it” (3:1) and that “existing cultural models[s]...provide an interpretative framework for making sense” of HIV and AIDS (acquired immune deficiency syndrome) (4:12). People and cultures adapt to the presence of the virus and its effects. Good social research acknowledges that behaviours are culturally produced and that, like the narratives of HIV infection, these behaviours change over time. Social research provides evidence that individuals, and more importantly communities, can act to change the behaviours and indeed social structures which may make them vulnerable to HIV.

What determines the spread of HIV is complex. The spread of HIV has never simply been a matter of unprotected sexual relations between men and women or men and men. There are many social and structural drivers of the epidemic; some are unique to place while others are not. Some of the drivers that have been claimed to fuel the spread of HIV in PNG include concurrent sex partners, trans-generational sexual relationships, strong gender differences, bride price when it is about ownership, lack of employment (formal and informal), access to the cash economy, low wages, violence towards women, cash payments for compensation claims, alcohol and gambling, greed, the abuse of power, campaign houses and mobility, amongst others.

In order to respond effectively (and I cannot emphasize the word *effectively* here enough) to the epidemic we need to do at least two things.

1. Build on the works of Jenkins, Hammar, Eves, Wardlow, Lepani and others to develop a strong capacity in social research which begins to chart and develop an understanding of the drivers of HIV infection in a given country, the effectiveness of the response and the partnerships built. In PNG this would include research into questions such as:

- What are the structural (social, political, cultural and economic) factors that lead to a generalized rather than a concentrated epidemic or even a mixed epidemic?
- What are the cultural and social impacts of this epidemic at the individual, household, community and national levels?
- What meanings do men and women give to their social and sexual lives that either inhibit or facilitate the prevention of HIV infection?
- How can communities respond effectively to the epidemic?
- What is the role of faith communities in responding to the HIV epidemic?
- Evaluating the effectiveness of HIV/AIDS programs: for example, do HIV/AIDS prevention campaigns meet the pedagogical needs of men and women, girls and boys?

In all our work we need to have a strong and permanent commitment to examining the gender dimension of all aspects of HIV infection in PNG: that is, men and women are each vulnerable to HIV but in different ways. Each experiences the impacts of the epidemic differently. But also, there are those aspects of the epidemic where the needs and/or experiences of men and women may be the same. A gendered analysis neither assumes difference or similarity between men and women. HIV social research allows us to ask these questions and approach the epidemic in ways where we can be sensitive to gender differences, because both quantitative and qualitative research methodologies facilitate the description and analysis of the social understandings, meanings and practices of peoples, institutions and communities in relation to HIV and AIDS. These social research questions are beginning to be taken seriously in PNG with the recent launch (September 2008) of the PNG National Research Agenda for HIV and AIDS 2008-2013 (5), which set out three priority themes:

- a) Increasing knowledge of the drivers of the epidemic and understanding the lives of those directly infected and affected by HIV and AIDS

- b) Evaluating the effectiveness and appropriateness of the national response to the HIV epidemic
- c) Measuring the impact of the epidemic on sectors and civil society.

2. In PNG we need to develop a complementary partnership between clinical, scientific and social research. This is not a naturally occurring relationship for these paradigms in their purest forms view and understand the world in biometrically different ways. However, an epidemic such as the HIV epidemic causes us to re-think this relationship and build a partnership. A partnership matters if we seek to have improved clinical and social support settings and good health promotion in PNG for all Papua New Guineans, not just some.

In the same way that the realization of the mysterious illness which presented amongst gay men in San Francisco in the early 1980s first generated the need for AIDS social research, subsequent developments in our knowledge around HIV infection changed the demands placed on HIV social research. This included, for example, that it was not only just gay men who were infected with this new illness, but that women, young people, injecting drug users, people with haemophilia and other groups such as African-Americans and Latinos were being infected and, furthermore, that HIV was not solely an issue of the developed world. HIV had become an issue of the developing world including PNG and thus research needed to be further adapted to address local issues and contexts. Though the epidemic in PNG has produced its own history with its own particular nuances, the social experience of the epidemic in PNG is not entirely unique.

The identification of the human immunodeficiency virus led medicine and clinical practice into a world dominated by pathogens and antigens, by DNA structures and by antiretroviral therapy (ART). In strict terms, medicine is concerned with making sense of biomedical markers of disease. Medicine is concerned with disease, the biomedical story of HIV, of opportunistic infections, of World Health Organization (WHO) clinical staging. It *can* be narrated as if it occurs in a vacuum of the sociocultural world. Not all clinicians do this, but there is a risk that a strictly biomedical approach to HIV functions to the exclusion of illness, the lived

experience of HIV infection. HIV social research has helped bring the person back into the picture, to bring the social aspects of the disease to the fore.

For example, as PNG scales up the roll-out of antiretroviral therapies it is important that we take a multidisciplinary approach to understanding, charting and valuing their impacts. The primary determinant of ART success is adherence. However, we learned from the very beginning that a doctor or nurse telling a person to take their treatment on time every day for the rest of their life will not stop a person from either missing their treatment or taking it at the wrong time. HIV social research tells us that there are social factors that support a person to adhere (6-8). In a recent study in Papua New Guinea on the social impacts of ART by the PNG Institute of Medical Research (PNGIMR) and the University of New South Wales (UNSW) (9) the findings indicate that issues of adherence are important. Of the 45.6% (N=374) of the sample who reported ever missing a dose of treatment the most common reason identified for not adhering was forgetting (66.5%). Other common reasons reported included not having enough food to take with medication (22.2%), being busy looking after children (20.4%) and that medication was a reminder that they have HIV (18.8%). Furthermore, there was a regional difference in adherence. Those who resided in the Southern Region (National Capital District and Central Province) were more likely to have ever missed a dose than those who resided in the Highlands or Momase Regions. These factors have to be taken seriously by clinical practitioners in the roll-out of ART programs. Clinical interactions require assessments of the likelihood of social adherence to ensure clinical efficacy adherence.

Asking different questions

Social research asks different questions to those asked by science alone, and these questions are critical. This at times can cause an analytical rub. Epidemiology and science by themselves are not sufficient for good health promotion. They allow us to plan and potentially target information delivery, but this information needs to be culturally and socially relevant, salient and sensitive if it is to be effective. This requires cultural and behavioural research that helps inform what is occurring and what might be done about

the epidemic.

With the expansion of ART into PNG and other resource-poor settings, HIV social research allows us to see that what matters in a person's life is not just that they are on ART, that their clinical markers are improving and that the desired numbers of people are on treatment. We come to understand the impact it has on their lives socially. For example, let me share a short, but true, story of the social impact of treatment on one woman in Port Moresby – in accordance with standard practice, this and other stories are made personal by the use of pseudonyms. Frances had been on the verge of death when her doctor prescribed her ART. In a short time she experienced renewed physical health. In biomedical terms her story was a success. However, despite experiencing renewed physical health this woman, against all medical evidence, stopped her treatment. Why? Because since she had returned to her former physical health her husband had resumed beating her. For her the price of ART was too high. The social cost outweighed the medical benefit.

As is the case everywhere, the cause and effects of illnesses are culturally constructed in PNG. As a result, cultures within PNG have developed a myriad of approaches to explaining, treating and curing illnesses. When seeking to understand health, illness and patterns of response to illness (see, for example, 10) in PNG, the deep-seated cultural constructions cannot be ignored. For example, in the highlands of PNG, *sanguma* (sorcery) is often assigned as the cause of AIDS-related deaths (unpublished data). Blame assignment of illness and death is crucial for social, cultural and spiritual resolution to take place.

Today, these cultural constructions of illness differ in their absorption and interpretation of modern western medicine. In the context of the HIV epidemic, the HIV/AIDS prevention and treatment programs and the roll-out of ART have been framed within a biomedical model of illness. Papua New Guineans living with HIV are being prescribed ART, which is governed by the biomedical construction of disease. However, they are consuming medication within their own cultural construction of illness. The effect of the tension between different constructions of HIV infection will have a significant impact on the success of HIV prevention and

treatment, including the roll-out of ART programs. We are already seeing this tension play out in the most dangerous of ways when people living with HIV/AIDS (PLWHA) convert to evangelical Christian churches such as the Revival Church in the belief that upon giving their heart to Jesus they will be safe from HIV (11) or, even more alarming, if they surrender their HIV treatment they will be cured. This discrepancy between cultural and medical modalities of bringing about healing was evidenced in the recent study by the PNGIMR and UNSW (9), where in a mixed-method convenience sample this tension was highlighted in the most vivid of ways. For example, a woman from Lae revealed in her interview that although she still carried her ART in her bag she was no longer taking her treatment. Her explanation for discontinuing ART was as follows:

"I believe that God healed my sick so that is why I stopped taking the medications. I was taking my medication when I was not converted but now that I am converted I see no use in taking my medication. I have faith and I believe that I will be cured. This is the result of sin and I have said sorry to God for my actions against you: I'm sorry; heal my sick, my sores, my worries and problems. I attend Revival Church and I believe that a number of people just like me have joined this church and have received healing and I am one of them." *Monica, Lae, 30 years of age* (unpublished data).

Supporting the same belief that Monica had in surrendering her ART for faith in a revivalist God, Mek from Mt Hagen shared this:

"The Revival Centres of PNG witnessed to me so I went to this church. I just went, got baptized and I got Holy Spirit, and Holy Spirit worked inside...I heard many testimonies of how God had healed them. Now I believe that God healed my sick too so now I am happy to live..." *Mek, Mt Hagen, age not recorded* (unpublished data).

However, others were saddened and indeed made angry by this false belief. In the Southern Highlands Province, where many of the participants reported knowing about PLWHA converting to the Revival Church, ceasing treatment and then dying, Thomas said this of trying to accommodate

cultural (religious) and medical paradigms of healing:

"Many of my friends that died, they told them you will be healed, don't take medicine and when they believe in them and when they left their medicine, they have their faith and they said, 'God will help me, I won't take my medicine', and the next moment they get sick and they die. I mean, my friends when they come to me to take their medicines, I usually tell them, 'Never believe in any Revival Church when they say okay, you will be healed so don't take your medicine. That's a lie.' I know that I believe in God. I believe in God but I do take my medicine. God doesn't make miracles like that so you are healed, no, God comes through medicine. God comes in love, through support. That's how you get your healing. That is why you get medicine and then you live long. So I've seen people who've quit their medicine and they say, 'God will help me', and they've just died – many." *Thomas, Mendi, aged in late 40s* (unpublished data).

Also from this same study the quantitative result regarding religious denominations reveals that PLWHA who identified themselves as members of the Revival Church were more likely to report lifetime non-adherence (64%) than members of other denominations; Seventh Day Adventists had the lowest rates of non-adherence with 35% reporting having ever missed a dose (9). While this study did not go into detail regarding religious beliefs and ART it did begin to point towards some important issues that need to be addressed where social research can begin to chart and explore the significance of cultural constructions of illness and healing and thus their impact on treatment.

Although a cultural construction, personal prejudice is not effective in responding to HIV. In this way, HIV social research has played a critical role in the development of non-discriminatory policies which aim to protect those who are HIV positive, ensure that they have access to treatment and care, and require that their status is kept confidential. There are also laws which aim to protect those who are most vulnerable to HIV, while at the same time acknowledging the responsibility of those with HIV not to intentionally further the transmission of the

virus. This has been seen in the HIV and AIDS Management and Prevention Act of Papua New Guinea 2003 (HAMP Act) and in other national HIV policies throughout the world. But sometimes policy is not enough.

The engendering of panic and prejudice was seen with the *Post-Courier* article titled 'Buried alive' (12). Whether what is said to have occurred in the article actually happened or not, violence of the kind described in it is illegal under PNG law and the article itself led to widespread panic and alarm in the community. Irrespective of the best laws, when propelled by fear people will act outside of them. People fear HIV because they do not understand it and because of the ways it has been brought to their mind. Responding with science or more education on biomedical facts alone will not meet the needs of the families who stand accused in the article of burying alive family members with HIV. A sociocultural response to this situation, and others like it, allows for the exploration of beliefs and values. By examining these factors which may have led to such violence, educators can begin to forge ways forward which are specific to the group's needs. By providing targeted and 'culturally appropriate' interventions based on evidence the lives of PLWHA in such families and villages can be best protected.

Changes in HIV technology: the example of provider-initiated testing on antenatal women

Social research has changed and adapted to the development of innovative health technologies related to HIV. Thus, while HIV social research has influenced medical and clinical practice (eg, adherence programs) biomedical advances have influenced the development of HIV social research. For example, in countries where ART has been used for a greater period of time, including the use of those classes of drug which cause lipodystrophy, some social researchers have explored the effects of lipodystrophy on body image (13). HIV medicine is new in PNG and thus it is only now that we are beginning to see the emergence of social research on ART here.

But social research also responds to changes in the use and implementation of HIV technologies such as HIV testing. The recent Minimum Standards for HIV/AIDS Services and Activities in Papua New Guinea

(14), where changes to PNG testing procedures are put forward, are of concern for HIV social scientists, especially those versed in the gender dynamics of the epidemic.

The 'opt-out' provider-initiated testing model proposed is one that Bradley (unpublished data) argues is rationalist and based on free choice. The hypothesis that underlines the model is that coming to know your HIV status will protect others (and yourself if you test negative) and that as a result of greater numbers of people being tested health services will be better able to rationally manage the demand for treatment and implement effective prevention programs. While there are many aspects of these assumptions which warrant greater scrutiny, this paper will only address those that affect women, in particular pregnant women. The assumption is that increased opt-out testing will reduce mother-to-child transmission and increase the number of women on ART.

In the Minimum Standards for HIV/AIDS Services and Activities in Papua New Guinea health care providers are instructed to test women who do not know their HIV status while "in labour or shortly after childbirth". Health care providers, it writes:

"...should use HIV rapid testing for pregnant mothers whose first contact with the health sector is during labour. Women who come to the health facilities after home birth should be offered postpartum HIV counselling and testing..." (14:38).

The '3 Cs' (counselling, consent and confidentiality) are fundamental underlying principles of the HIV/AIDS Management and Prevention Act (the HAMP Act) 2003 of Papua New Guinea. Specifically the HAMP Act states that a person must give consent to be tested because he or she is willing to be tested and not because he or she has been coerced or induced by payment, or is afraid, forced or tricked. Consent can only be given after pre-test counselling where information on the nature of HIV, transmission, the testing process, the legal and social consequences of an HIV-positive test result, post-test counselling and medical support are given. Informed consent can only be given where post-test support is available. To satisfy the law in PNG all pre- and post-test counselling must be done one-on-one,

in private. With provider-initiated counselling and testing (PICT) and where testing is done in the antenatal setting, where privacy is not guaranteed, then issues of confidentiality, which requires that a person's HIV status, whether a person has had an HIV test or is seeking or going to have an HIV test, whether a person has refused an HIV test or whether a person is related to a person with HIV, be kept confidential, become problematic. The effect of voluntary informed consent is that it is against the law to give consent to an HIV test in a group (unpublished data).

To a social researcher concerned with the principle of informed consent in HIV testing the question then becomes: how can a woman in particular, or women in general, give informed consent in these circumstances, where she is either in labour or recovering from delivery and trying to feed her newborn child, and where there may be next of kin around? If consent is given (I am not sure it could ever be informed in this context) how does she cope with a positive test? To learn that one is HIV positive is a significant discovery, let alone while you are pregnant.

A paper presented by Dr John Irima at a Specialist Meeting on Sexually Transmitted Infections at the 2007 PNG Medical Symposium reported that in Goroka Base Hospital between October 2005 and October 2006, 58% (35 out of 60) of the women who tested HIV positive in the antenatal clinic (ANC) did not return for delivery. Of the 25 women who did return, none returned after delivery for further ongoing care, which resulted in all being lost to ongoing follow-up care and support (unpublished data). At a rural ANC where PMTCT (prevention of mother-to-child transmission) is run by the Catholic Church, one that is renowned for exceptional HIV care in difficult geographical and social circumstances, of the 17 women who returned positive test results, 7 women (41% of those testing positive) were lost to follow-up. Moreover, all the women from these two sites had opted in to be tested for HIV.

The point of testing women in the antenatal setting is to bring them into care and to prevent the transmission of HIV to their unborn child. When women did not return for delivery, they did not receive ART during labour, and anyone who supported them during the delivery in the village may have

been at risk of infection due to the absence of gloves and infection control procedures. As well, these women and those who delivered but who were lost to follow-up received no ongoing support with feeding (more than likely breastfeeding). Testing these women seems (retrospectively) to have been unhelpful and unlikely to have achieved the very public health goal of preventing transmission to an unborn child that the test was meant to achieve.

These rather frightening statistics raise some important questions that need to be considered.

- Why do so few women who test positive for HIV return for delivery and follow-up?
- What will happen to these figures with the introduction of opt-out testing?
- What will be the social outcomes for women of this shift in policy?

To put it bluntly, what are the benefits of increasing testing of antenatal women if women continue not to return for delivery or are lost to follow-up?

This policy shift to 'opt-out' in the PNG context has occurred without an evidence base of what the issues are for women undertaking HIV testing in the ANC and entering a continuum of care for HIV-infected people. We actually know very little about PNG's HIV-positive antenatal mothers and why so many are declining to accept treatment or the care and support offered post-delivery. We certainly do not know what the clinical and social impact is likely to be of the change from opt-in HIV testing for pregnant women. This is a large gap in our knowledge of the epidemic in PNG. However, we do know a little about the situation in other resource-poor settings.

Recent research in India shows that, irrespective of their test results after undergoing PICT in the antenatal setting, women said that they felt pressure by the health care worker to undergo the test. In such contexts, the ethical concerns of informed consent become paramount (15). Power differentials between health care workers and female patients make it difficult for women to make choices to 'opt-out' in the

clinical encounter.

Other international research tells us that women's experiences of HIV status disclosure are mixed. In some studies of women who tested HIV positive a significant proportion experienced negative consequences upon disclosing their status. These included physical and emotional violence, abandonment, discrimination and financial difficulties (16-19). In one Tanzanian study the primary reason women gave for not disclosing their HIV status was fear of abandonment (20). These findings reinforce other studies which have shown that women who are HIV positive report more lifetime violence from intimate partners (21). However, among these stories there are also those of women who experienced responses of support and understanding from partners upon disclosure (16,22-23). However, if one of the goals of HIV testing is to prevent further transmission (including to sexual partners) then it becomes problematic when we know that women who test HIV positive in the antenatal setting are less likely than other women to disclose their status to sexual partners (between 17% and 32%) (24).

I cannot help but fear that as the epidemic becomes more widespread and more complex and we are challenged to think in more dynamic ways, governments and some health care providers see PICT as a quick fix to the HIV problem. Social research demands that we think in ever more complex ways. Together with clinicians we can do this for mutually beneficial gains to improve the well-being of people with HIV and to reduced the transmission of HIV to children.

In order to improve the health and social outcomes of women, their children and families a multidisciplinary approach between health care workers and social researchers is needed. Unless such a partnership develops, more women may test but many may not return. This is a critical opportunity for a partnership approach in order to care for women with HIV and prevent parent-to-child transmission. Both clinical and social indicators need to be taken into account for successful testing and treatment programs.

Conclusion

The adoption of findings from well-informed social research has the capacity to lead to better health outcomes for PLWHA

through, for example, improved clinical practice, a reduction in stigma in the community, and identification of long-term care and support needs. HIV social research needs to be taken seriously because above and beyond what it can do for those with HIV, it has the potential to show the ways forward in HIV education which can reduce rates of HIV infection in our communities and families.

Social research has also played a role in HIV education, helped generate national and international responses, helped develop greater understandings of behaviour over time, helped plan for prevention and care, and been instrumental in the monitoring and evaluation of national and provincial programs.

As Papua New Guinea's response to HIV continues to develop and as the government begins to show financial and political commitment to HIV social research then a growing evidence base from which to act will deepen. This, along with multidisciplinary dialogues and collaboration on approaches to HIV/AIDS prevention, treatment, support and care, will only better serve PLWHA.

With an ongoing commitment to HIV social research this evidence base will continue to play a vital role in PNG's response to the epidemic because it is here that people's voices and experiences are heard, whether they are expressed as quantitative numbers, which tell us what is happening, or qualitative narratives, which tell us the why and how of what is happening. Furthermore, as HIV technologies are developed and are applied in new ways social research will be able to complement clinical research by asking different questions, by bringing the social to the fore, by understanding the drivers of the epidemic and by developing a paradigm by which to respond in culturally relevant ways. Together in partnership both social and biomedical research and their application have the power to change the way we in the health sector care and act for the citizens of Papua New Guinea, including those living with HIV and those vulnerable to infection.

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Common themes in the literature on traditional medicine in Papua New Guinea

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SUMMARY

A review of the literature on traditional medical practices and beliefs in Papua New Guinea (PNG) was conducted in order to provide context and background information for the Department of Health's National Policy on Traditional Medicine for Papua New Guinea. The literature review examined accounts that refer to all 19 provinces and 50 different cultural groups. PNG is renowned for its cultural diversity and it was evident in the literature review that many beliefs and practices are specific to particular cultural groups. Many cultural groups adopt unique practices based on their own specific explanations of illness. At the same time, the review identified a number of commonalities in concepts of health and illness, treatment-seeking behaviour and reactions to the introduction of western medicine among Papua New Guineans from different geographic areas. Both the diversity and the commonalities provide context and background for the National Policy that was approved by the National Executive Committee in March 2007 and officially launched in April 2009. The commonalities are pertinent to the policy on a national level while the diversity must be considered when the policy is implemented at the local level. Summarizing the commonalities between different cultural groups illuminates central belief and behaviour constructs relating to health and illness. Ideas and similarities in practice or perceptions relating to traditional medicine in PNG that are common across a number of provinces are the subject of this paper. The most common features include a belief in the power of sorcery, which is universal, the importance of adherence to customary law and the healing power of herbs and incantation. These findings are a working draft of the expected norms of traditional medicine in PNG, which can be tested and refined during the process of implementing the National Policy, which, it should be noted, explicitly excludes the use of sorcery.

Introduction

There are many reports about traditional medical practices and beliefs in Papua New Guinea (PNG), some of which date back to the first half of the 20th century. PNG is renowned for its cultural diversity and this is evident in the literature on traditional medicine. With regard to traditional medical practices and beliefs, there is diversity not only between provinces but also between cultural groups within the same province (1). Notwithstanding this diversity, some uniformity in the underlying beliefs from which traditional practices stem is also evident in the literature.

PNG's extreme cultural diversity makes it difficult to provide a comprehensive, systematic review and situational analysis on traditional medicine. However, a significant contribution to that task was made in reviewing the literature on traditional medicine on a province-by-province basis and identifying commonalities in beliefs, practices and factors that motivate or influence service utilization (2). The review looked at accounts from all provinces and from several cultural groups within some provinces. Because of PNG's cultural diversity it should be remembered that a description of one cultural group cannot be taken as representative of a whole province

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or region.

Despite location-specific idiosyncrasies there are a number of commonalities in concepts of health and illness, treatment-seeking behaviour and reactions to the introduction of western medicine among Papua New Guineans from different geographical areas. This report highlights common themes, concepts and practices from the literature on traditional medicine in PNG. Since the review of the literature was not intended to be exhaustive, and, even if it were, not all groups will be represented, the omission of an association between a theme/concept/practice and a particular province may simply reflect a lack of information rather than the absence of that theme/concept/practice in that province. However, the significant similarities that this review has found across the whole country are of particular interest.

Classification of illness

Cultural groups in many parts of PNG distinguish between illnesses on the basis of severity. Many groups use the broad illness classification system of serious and minor illnesses. Illnesses included in the minor category are those due to natural causes, contagious illnesses, illnesses that have been introduced since European contact and illnesses that affect children. Serious illnesses are distinguished by the involvement of supernatural forces. Groups in many provinces including Oro (3), Central (4), Western (5), Bougainville (6), West New Britain (7-9), Morobe (10), Madang (11,12), East Sepik (13,14), Sandaun (15), Eastern Highlands (16), Western Highlands (17), Enga (18) and Southern Highlands (19) use this illness classification system.

Manusians distinguish between earthly and divine illnesses caused by supernatural forces and the Christian God respectively, which may well correspond to the serious and minor categories used elsewhere (20). In Madang the classification system is more elaborate, involving 6 categories of illness. However, these 6 include natural illnesses and 3 separate categories for illnesses caused by supernatural forces (taboo violation, sorcery and spirits) (11).

In several provinces, including Oro (3), Bougainville (6) and East Sepik (14,21), another illness category is in evidence. 'Sik

bilong ples' or illness of the village/settlement refers to serious illnesses that are thought to be related to social discord or community conflict and mediated by supernatural forces (22). When members of the same clan or residential group are afflicted with the same symptoms, 'sik bilong ples' would be suspected. This classification may be another interpretation of the serious versus minor dichotomy as the alternative to 'sik bilong ples' is 'sik nating', which translates as minor illness or illness without cause.

Causes of illness

Even more pervasive than the minor versus serious illness classification system is the belief in supernatural causes of disease. Reports from all provinces implicated spirits as disease-causing agents. Spirits may be ancestral kin, and may be unrelated to or associated with geographic features. Similarly, reports from all provinces except Simbu made explicit reference to sorcery ('poisin' in Melanesian Pidgin). Sometimes sorcerers invoke the powers of spirits. In most cultural groups sorcerers are thought to possess the power both to cause and cure illness but beliefs about the specific associations between health or illness and sorcery vary across provinces. In Gulf, the Elema believe that magic ('puripuri') can be used to either heal or harm via sorcery (23). In the past, like many other cultural groups, the Elema attributed every death to sorcery, whereas in recent times, while the tendency to blame sorcery for deaths exists, not all deaths are attributed to sorcery (23). The Gijura of Western Province attribute mental and physical illness to sorcery (7). In the Eastern Highlands, the remarkable 'shaking disease' or kuru that afflicted the Fore was thought to be caused by sorcerers casting spells on their enemies (24). Simbus do not believe sorcery results in death but they may believe that sorcery causes illness (25). The method by which the *aba* (worms) of the Nimai from Simbu Province are thought to inflict illness (26) is similar to that reportedly used by sorcerers in many provinces. In the context of traditional medicine it must be remembered that, although the practice of sorcery is common and many Papua New Guineans would consider it to be part of traditional medicine, its use as a form of traditional treatment is not recognized or endorsed by the National Policy on Traditional Medicine for PNG, which seeks to improve access to safe and effective forms

of traditional medicine. The Policy explicitly states that sorcery and other related dangerous practices will not be incorporated into the formal health care system.

Violation of taboos, failure to observe social obligations and discordant family or social relationships also featured strongly as causes of illness. In many instances these causes of illness are mediated or perpetrated by spirits whose role is to preserve traditions and social harmony. Taboos of various types – food, geographic or social – may be broken. A common breach of taboo is to trespass in a sacred place or on land belonging to someone else. This belief was evident in East Sepik (13), Madang (27), West New Britain (7), Bougainville (2), Sandaun (15), Eastern Highlands (16, 28) and Enga (18). Illness may result as a consequence of action by spirits or poison inflicted directly by a sorcerer or indirectly through the trespasser coming into contact with a poisoned object such as a tree trunk, as in Eastern Highlands (16) and West New Britain (7). It is also commonly forbidden to venture into places associated with one's clan totem or to consume one's clan totem, which may be a bird, fish or animal. Failure to observe such customs may give rise to injury (29), complications during childbirth (7,13), birth defects (7) or vomiting (18,27). Table 1 summarizes references in the literature to the various supernatural forces that people in different provinces believe cause illness.

Some of the less commonly expressed causes of illness include loss of soul (Milne Bay (7), Eastern Highlands (30)) and contamination from women or sexual intercourse (East New Britain (31), West New Britain (9), Simbu (26), Eastern Highlands (32), Southern Highlands (33)). Natural causes of illness may be the elements such as wind or water (Central (7), Bougainville (34)), earthquakes (East New Britain (31)), pollution (East Sepik (14,21), Eastern Highlands (32)), contagious elements such as viruses or bacteria (East Sepik (13), Western (5), Bougainville (29), West New Britain (9)) or the natural ageing process (Madang (12)).

Cultural groups in several provinces share the idea that illness is related to the state of a person's blood. The Maenge of East New Britain believe that blood becomes dry and hot and accumulates in one part of the body when a person is sick (31). In New Ireland,

blood features in the Lihirian concept of illness – black or bad blood is thought to accumulate at the site of injury and releasing it can effect a cure (35). In East Sepik, the Boiken believe that good blood is gradually displaced by bad blood as a person ages and their health degenerates (21). Similarly, the Ommura of Eastern Highlands believe that good health is related to freely flowing blood (32).

In Oro (3), Bougainville (6), West New Britain (9) and East Sepik (21) the cause of illness, and therefore diagnosis, is not determined until a cure has been found. During the course of an illness a gradual, iterative process of eliminating possible causes is engaged upon. As various treatment options prove unsuccessful possible causes of the illness are eliminated until one or several treatment options are eventually deemed to be successful, thereby indicating the actual cause of the illness.

Traditional treatment modalities

Traditional medicine in PNG incorporates a range of treatment modalities. While particular rituals or practices may be unique to certain cultural groups, there is a raft of practices that are common in many provinces. A large part of traditional medicine is based on remedies or treatments made from plants or trees. In many communities there is a broad general knowledge of plant preparations that can be used for basic first aid without recourse to a traditional healer. For more specialized knowledge a traditional practitioner or a sorcerer is likely to be required. Traditional healers are benign and open; sorcerers are malignant and usually hidden but if they offer counter-sorcery they will, at least in this role, be open (though their methods may not be). Shamans, with their professionalism, performance rituals and paraphernalia, are open; but they are not commonly found in PNG societies, with the notable exception of the Anga of the Eastern Highlands (30) and some groups in Bougainville (34). For the purpose of the present analysis, what is important is the common theme of recourse by the sick to the traditional expertise of a local healer of some kind or another. Spiritual healing, bloodletting and massage are also components of traditional medicine. The various types of traditional treatment in common usage in each province are presented in Table 2.

TABLE 1

COMMONLY PERCEIVED SUPERNATURAL CAUSES OF ILLNESS

Province	Spirits	Sorcery	Taboo violation	Social transgression	Witchcraft
Bougainville	X	X	X	X	
Central	X	X			
East New Britain	X	X			
East Sepik	X	X	X	X	X
Eastern Highlands	X	X	X	X	
Enga	X	X	X	X	X
Gulf	X	X			
Madang	X	X	X	X	
Manus	X	X	X	X	
Milne Bay	X	X	X	X	X
Morobe	X	X	X	X	
New Ireland		X			
Oro	X	X	X	X	
Sandaun	X	X	X	X	
Simbu	X		X		
Southern Highlands	X	X	X	X	
West New Britain	X	X	X	X	
Western	X	X			
Western Highlands	X	X	X	X	

Treatment preferences

Just as cultural groups from many parts of PNG have adopted the minor versus serious classification system, there are also similarities in the type of treatment deemed appropriate for particular types of illness. Serious illnesses, which are those caused by some type of supernatural force, require traditional medicine in order to be cured. The cure may incorporate plant or herbal preparations but is likely also to involve some

type of ritual, which may be conducted by a traditional healer or a sorcerer. Minor illnesses, in contrast, can be treated with simple herbal or plant remedies, which may be known to the afflicted person or their family, or western medicine, or may clear up without treatment. Thus traditional medicine tends to be used for more serious illnesses or where supernatural forces are thought to be the cause of illness. Western medicine, usually acquired through the local aid post, is more often used for minor illnesses but may

TABLE 2

TRADITIONAL TREATMENT PRACTICES

Province	Home care	Plant remedies	Sorcery*/incantation	Spiritual healing	Blood letting	Massage
Bougainville	X	X	X	X		X
Central	X	X	X		X	X
East New Britain		X	X	X	X	X
East Sepik		X	X		X	
Eastern Highlands	X	X	X	X	X	
Enga			X			
Gulf			X			
Madang		X	X	X		
Manus	X	X	X	X		
Milne Bay		X	X	X	X	
Morobe		X	X	X		
New Ireland		X	X	X	X	
Oro		X	X	X		
Sandaun		X	X		X	
Simbu				X		
Southern Highlands	X	X	X	X	X	X
West New Britain	X	X	X		X	
Western	X	X	X			
Western Highlands		X	X			

*Although common to many provinces, sorcery is considered dangerous and is not one of the traditional treatment practices that will be incorporated into the health care system under PNG's National Policy on Traditional Medicine

be used for symptom relief in serious illness or as an adjunct to traditional medicine. It is not uncommon to use western medicine for the relief of symptoms while using traditional medicine to treat the root cause of the illness. This delineation for treatment preferences was reported in Oro (3), Western (5), Bougainville (6), West New Britain (8), Madang (11,12), Eastern Highlands (36),

East Sepik (37), Sandaun (38) and Southern Highlands (39). It is worth noting that a cure of serious illness effected by western medicine in such circumstances will tend to reinforce its adjunct role in the traditional belief system.

Although there may be a preference for either western or traditional treatment

modalities in particular instances in some areas, medical pluralism is evident in nearly all communities. Reports from Milne Bay (40), Oro (3), Central (4), Western (5), New Ireland (35), Bougainville (34), West New Britain (8,9), Madang (27), East Sepik (14), Eastern Highlands (30) and Southern Highlands (41) indicated that the practice of using both western and traditional medicine either simultaneously or sequentially is common. Several reports suggested that Papua New Guineans have willingly experimented and accepted western medicine while maintaining traditional treatment practices. In Western Province (5), Bougainville (6,29,34), Manus (20), West New Britain (8), Madang (12,27), East Sepik (21) and Southern Highlands (33,39) it has been reported that people see western and traditional medicine as being compatible and part of one medical system. The range of treatment options was simply expanded with the introduction of western medicine. In many instances treatment choices are pragmatic and based on factors such as cost and convenience rather than a structured hierarchy of preferences. Pragmatic choice of treatment options was reported in Milne Bay (40), Western (5), New Ireland (35), Bougainville (6), East New Britain (42), West New Britain (8), Manus (20), Madang (27) and East Sepik (21).

While western medicine appears to have been readily assimilated there were a number of provinces where it was reported that traditional medicine was likely to be the first treatment resort. These included Milne Bay (40,43), Oro (3,44), East New Britain (42), Manus (45), East Sepik (21), Sandaun (37) and Eastern Highlands (28,30). This preference may be driven by pragmatism or the perception that an illness is in the dominant, serious category. The integration of western and traditional treatment modalities has been greater where communities have rationalized western medicine in terms of their traditional understanding of disease processes, as in Western Province among the Ningerum (1) and the Amele (27) and Maring (12) of Madang.

A recent study in the Nasioi area of Bougainville (46) reinforced the findings of the literature review regarding treatment preferences. The study found that western medical treatment and explanations of illness have been accepted and assimilated by the

study population but have not displaced the use of traditional healers or traditional beliefs. Responses to illness and attitudes towards the two treatment modalities also reflect a high level of acceptance of and confidence in both traditional and western medical paradigms and systems. Practical circumstances at the time of illness often determine which treatment option is used; however, if spirits, sorcery or other supernatural agents are implicated as causes of an illness a traditional healer will almost certainly be approached for treatment.

Organization of traditional health care

There are also similarities across provinces in the organization of traditional medicine. It could be said that traditional medicine in PNG is characterized by its lack of formal organization and its ubiquity. In some communities in Oro (3), Western Province (5), Bougainville (6), East New Britain (42), Southern Highlands (19) and Eastern Highlands (30) there is widespread general knowledge of a range of basic traditional therapies. Home care is often tried before consulting someone with more specialized knowledge and skills unless the ailment is perceived to be serious at onset. Specialist healing knowledge and skills may be retained by a selected few healers within the community or local area. Powers of divination and counter-sorcery may be held by an even more limited number of people. Knowledge of traditional therapies is usually passed down from generation to generation within families as in Oro (3) and Bougainville (34). Healers may be male or female. In some highland areas traditional healers charge high fees, especially for perceived serious illnesses; elsewhere, for example in Oro (3) and Bougainville (34), there is no set fee but practitioners accept a small cash payment or gift at the discretion of their patients.

This is the situation found in the Nasioi area of Bougainville (2). Most households possess knowledge of basic home remedies and three-quarters of respondents try to manage their condition at home before approaching someone with more specialized healing knowledge. Traditional medicine exists in the informal sector but a plethora of traditional healers, both male and females, live in the area with one or more practising in each of the 97 villages where interviews were conducted. Despite the existence of many

traditional healers only a few are well-known suggesting that specialized knowledge and/or superior skills are retained by only the minority of traditional healers. Fees charged vary between practitioners but are generally K2 or less. The matter of payment is often left to the discretion of patients and may be in kind rather than cash.

As the length of exposure to western medicine increases, knowledge of and interest in traditional practices appear to be waning. In some of the communities

described, such as among the Dipida (47) and the Maring (12), it was noted that younger generations have little knowledge of traditional practices. However, given the underlying concepts about causes of illness and death that continue to prevail it is difficult to imagine that traditional practices will die out in the near or even medium-term future.

Conclusion

A summary of the 50 language groups included in this review, by province, is given

TABLE 3

LANGUAGE GROUPS INCLUDED IN THIS REVIEW BY PROVINCE

Province	Cultural groups studied
Bougainville	Nukumanu (29), Simeku (6), Siwai (6), Buin (34), Nissan (34), Petats (34), Tinputz (34), Nasioi (2,46)
Central	Motu (7), Hula (4)
East New Britain	Tolai (7,42), Maenge (31)
East Sepik	Abelam (14,22), Boiken (21), Wam (13), Urat (37)
Eastern Highlands	Ommura (32), Simbari (30), Gimi (16), Fore (24), Agarabi (28), Gadsup (28), Tairora (28), Kamano (28), Morei (14), Asaro (36)
Enga	Enga (18)
Gulf	Elema (23)
Madang	Amele (27), Didipa (47), Rao-Breri (11), Maring (12)
Manus	Manus (20,45)
Milne Bay	Tawala (7,40,43), Vanatinai (40)
Morobe	Yupno (10)
New Ireland	Lihir Island (35)
Oro	Maisin (3,44)
Sandaun	Gnau (15,37,38)
Simbu	Simbu (25), Nimai (26)
Southern Highlands	Huli (33,39,41), Kaluli (19), Waragu (19)
West New Britain	Lusi (9), Kove (8), Bakovi (7)
Western	Ningerum (1,5), Gijura (7)
Western Highlands	Melpa (17)

in Table 3. The diversity in cultural groups and their unique beliefs and practices relating to health and illness provide a seemingly endless source of fascination for people from more monochromatic cultures. In the past this diversity has made it difficult to treat PNG as one entity when summarizing issues or developing policies that need to be both nationally and locally relevant. Although less colourful than accounts detailing unusual beliefs and customs, this report has identified several basic constructs relating to beliefs about health and illness and treatment preferences that are common to more than a handful of PNG's many cultural groups. Many Papua New Guineans distinguish between serious and minor ailments and attribute serious illness to supernatural forces. Western medicine has been accepted but traditional medicine continues to be widely used. The introduction of western medicine has expanded the range of treatment options rather than rendering traditional medicine obsolete. Choice of treatment is often pragmatic. Western medicine may be used to relieve symptoms or treat minor illnesses but when supernatural forces are implicated, traditional medicine will be required to treat the cause. Medical pluralism is common.

Within this context, the official endorsement and launching of a National Policy on Traditional Medicine for PNG is timely. The Policy was developed from a set of guidelines formulated at a national workshop on traditional medicine held in 2004 (48) where scientists, researchers, manufacturers, practitioners and health planners all collaborated. The Policy acknowledges the importance of traditional medicine to many Papua New Guineans and the contribution traditional practitioners could make to the health system which, in its present form, struggles to adequately serve the population. Incorporating traditional practitioners into the formal health care system will engender greater levels of organization and recognition and promote the longevity of important traditional knowledge. Already some progress has been made by the Department of Health in implementing the Policy, with the formation of several provincial and district associations of traditional medicine practitioners and the development of a training package for traditional practitioners. If the Policy is carefully implemented with regard for the lessons to be learnt from the experiences of others who

have tried to integrate traditional and western medical systems, PNG has much to gain. An examination of international experiences of integration has produced a set of principles that are relevant to PNG and might be used to guide the implementation of the Policy (2).

The National Policy is necessarily broad as it relates to the whole of PNG. Implementation of the Policy should be tailored to suit the specific needs, preferences and situations of recipient communities. It will not be appropriate to attempt to develop a health system that combines both western and traditional medicine in all communities. In places where traditional medicine is not recognized or has no semblance of organization it may be difficult to implement the National Policy. To determine which communities are ready and how the Policy should be implemented in different communities will require background information relating to behaviour and attitudes toward traditional medicine at community level. The findings of this paper should be regarded as a working draft of the expected norms of traditional medicine in the cultures of PNG. They should be tested and evaluated in use, in the community, in the clinic, in assessing reports and in reading the anthropological literature. Further information for specific groups could be gathered using focused ethnography and rapid assessment procedures. If implementation of the National Policy can be made locally relevant through tailoring to suit recipient communities the result could be a health care system that is better aligned with people's understanding of health and illness. A health care system that is congruent with concepts of illness, illness causation and treatment preferences may be better utilized and thus eventually lead to better health for Papua New Guineans.

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Malaria survey and malaria control detachments in the South-West Pacific Area in World War 2

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SUMMARY

Malaria among troops in the South-West Pacific Area (SWPA) in World War 2 affected the military effort to the degree that special units were formed to combat it. These malaria survey detachments (MSDs) and malaria control detachments (MCDs) were self-contained and so could move quickly to wherever their services were needed. In SWPA by 25 September 1944 there were 32 MSDs and 65 MCDs. Tables of organization called for 11 enlisted men in MSDs and MCDs, two officers in MSDs and one in MCDs. Detachments served throughout the SWPA. Detailed records of the 31st MSD show that in addition to antimalarial efforts it worked at control of scrub typhus, dengue and venereal disease, at reduction of rat populations and in experimental work involving DDT and schistosomiasis. Specific locations of the 31st MSD were New Guinea (3 sites), Morotai, Leyte, Mindoro, Okinawa and Japan. The detachment served overseas for 21 months. Experience in combating malaria in SWPA in World War 2 points to the need for better and continuous training of both medical and line officers in malaria prevention and control.

Introduction

Malaria survey detachments (MSDs) and malaria control detachments (MCDs) played a significant role in the near elimination of malaria as a threat to the armed forces in the South-West Pacific Area (SWPA) in World War 2, as the following quotation clearly emphasizes:

“The reduction of malaria attack rate in this theater to a point at which it no longer constitutes a dangerous handicap to our military effort is an achievement of historical importance in preventive medicine. It has been the result of a joint effort which is to the great credit of all who have participated. In this accomplishment the malariologists and the malaria survey and malaria control units have played the major role. Despite hardships and often danger, their achievements have been notable. The Medical Department is proud of your initiative and perseverance, of your professional contributions, and of the striking success of your efforts.” (1)

It is surprising, therefore, that in writing the

history of that great conflict, there is no published record of details of the personnel structure, the equipment, the training, the places of operation and the specific kinds of work accomplished by these units. This paper is an attempt to fill that gap using whatever documents exist and can be found.

Background

Well before military land campaigns began in the SWPA, it was clear that malaria would be a major problem in that these areas were known to be highly malarious. The developmental history of the military organization needed to fight this scourge has been well told. The following is a brief summary taken from several of these sources (2-6).

After study of the problem during 1942, the Office of the Surgeon General (OSG) proposed:

- 1) the assignment of trained malariologists to malarious areas,
- 2) the formation of special units to

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determine and control the local factors in malaria incidence, and

- 3) the education of troops in protective measures.

Condon-Rall (7) reports that, "The Joint Staff planners sought to provide each reinforced division of about 20,000 troops... with... one malaria control detachment and one malaria survey detachment."

Next, on 24 October 1942, the Surgeon General sent a letter to the Commanding General, US Army Forces, South-West Pacific, outlining this new approach and inviting him to submit requests for the additional personnel without delay. As a result, an organized attack on malaria began. The first malariologists and an echelon of three MSDs, designated as units at that time, were sent by air to the South-West Pacific in February 1943. By June, MCDs also were at work. This was none too soon. After long and bitter fighting, the battles for Guadalcanal and Papua New Guinea (from Finschhafen southeastward) had been favourably concluded, but with many troops, both Australian and US, continually being removed from action by malaria. Malaria rates in certain circumscribed areas were especially high. For example, in January 1943, US troops in the Milne Bay area of Papua New Guinea had a malaria attack rate of 3308/1000 men/annum. But even the average rate in February among US forces throughout New Guinea was high, 970/1000/annum. At that time General MacArthur, already familiar with the ravages of malaria on Bataan, said, "...this will be a long war if for every division I have facing the enemy I must count on a second division in hospital with malaria and a third division convalescing from this debilitating disease!" (7) Unfortunately, as then Colonel Russell, chief malariologist on MacArthur's staff, points out, "It is a simple truth that, in an army, discipline is as important in fighting disease as in fighting the human enemy. But this seemingly obviously important fact was almost completely forgotten in the early months of World War II ... Most line officers and all too many medical officers at the beginning of World War II were ignorant about malaria and its potential for disrupting military operations." (8:75)

Though control of malaria came more slowly than commanders and their troops

desperately needed, forces began to be assembled in numbers to combat the disease. On 25 September 1943 there were 12 MCDs and 5 MSDs in SWPA, and by June 1944 18 MSDs and 29 MCDs were at work in 17 locations along the northeastern coast of Papua New Guinea. On 25 September 1944, the total in theatre and assigned to it was 65 MCDs and 32 MSDs. In addition to the specialized MSDs and MCDs, details of men within military units were assigned to perform malaria control (9:538-539). Personnel from MSDs and MCDs were utilized in training these men overseas. In SWPA, training of officers in malaria control took place in Brisbane, Australia and later in Finschhafen, Papua New Guinea, beginning in September 1943. Somewhere between 1500 and 2000 officers received this training (5:15). Coincident with this increase in the number of personnel involved in the attack on malaria, rates fell dramatically. In Milne Bay, a year after the attack rate of 3308/1000/annum reported above, it had fallen to 31/1000/annum.

Though it is beyond the scope of this study, malaria was a problem in many theatres of combat in addition to the SWPA. It is a measure of the importance given to antimalarial efforts that, by the end of the war, a total of 159 MCDs and 68 MSDs had served in all theatres overseas and more than 60 malariologists had been assigned. The total personnel specifically designated for antimalaria work overseas was approximately 350 officers and 2500 enlisted men (EM) (10).

Malaria survey and malaria control detachments

Malaria can be attacked in three ways:

- 1) by either killing or suppressing the reproduction of the malaria parasite in the human host,
- 2) by killing the mosquito transmitting agent in either its larval, pupal or adult form, and
- 3) by instructing troops in mosquito control and in those protective measures which reduce the chance of being bitten by a mosquito, and by providing the bed netting, repellents, insecticides etc which make it possible to carry out those measures.

Method 1, the development of effective antimalarial drugs in a joint civil-military effort, has been fully chronicled by Condon-Rall (7). By December 1943, production of the primary antimalarial drug, atebine, had reached 85% of scheduled capacity (8). This drug together with instruction of troops and the enforcement of antimalaria discipline was of great importance in winning the war against the mosquito-malaria parasite axis. Methods 2 and 3 were the province of malariologists, unit details, and of MSDs and MCDs.

The mission

The mission of MSDs was to:

- 1) determine incidence, distribution and biology of mosquito adults and larvae in relation to malaria,
- 2) survey, map and recommend to commanders measures for malaria control in specific areas,
- 3) maintain a check on effectiveness of control measures by routine collection of adults and larvae,
- 4) perform malaria parasite surveys among civilians and troops to determine incidence and species of parasites,
- 5) perform any special studies in regard to malaria and mosquito-borne disease as required by the Chief Surgeon, and
- 6) keep commanders informed on all matters relating to malaria control in their areas.

The mission of MCDs was to:

- 1) prepare detailed plans for malaria control measures,
- 2) demonstrate and advise unit antimalarial details on approved methods of control,
- 3) advise the commander on the use of labour, civilian and native, in malaria control work,
- 4) initiate plans and advise commanders regarding the maintenance of control measures in areas between units, docks, airfields and similar areas used by troops of all units, and

- 5) keep commanders informed on all matters relating to malaria control in their areas (9).

Tables of organization (T/O) for MSDs and MCDs

The history of the authorization and development of special antimalarial units is given by McCoy (5). The earliest T/O for MSDs and MCDs located in the files of the National Archives and Records Administration (NARA) is dated 29 December 1942 (11:38-41). Personnel authorized in tables of organization and equipment (T/O&E) 8-500, published on 23 April 1944 (11:42-51), are essentially the same (Table 1). This T/O was not always strictly adhered to. A T/3 (Technical Third Grade) transferred into the 31st MSD was retained as such. The second officer in the 31st MSD was a virologist/epidemiologist, not a parasitologist, but his training was broad and he served well. Although a Technical Sergeant and a Staff Sergeant are authorized, the 31st MSD had only a T/3.

Initially, units were formed in response to requests from commanders in the field, but delays of 2 to 4 months could readily occur due to the specialized training required (assuming that some men would not have finished basic training or enlisted technicians' schools), plus the delay of transportation. This suggested that a pool of fully trained units was needed. Accordingly, an active pool of 20 control and 10 survey units was proposed.

Tables of equipment (T/E) for MSDs and MCDs

Specialized T/E had to be designed for these newly created detachments. In addition to the usual personal gear there was a considerable amount of equipment of a specialized nature. This included: microscopes; glassware; chemical reagents; insect collecting, rearing, preserving and storing materials; equipment for mapping, ditching, draining and spraying; and much else. The earliest T/E in NARA is dated 29 December 1942 (12). Over time, operations in the field necessitated additions of items. Some items found to be unnecessary were deleted. The T/O & E 8-500, 23 April 1944 (11:42-51) gives a good sense of the amount and types of equipment carried by MSDs and MCDs and is summarized in Table 2.

TABLE 1

TABLE OF ORGANIZATION FOR MALARIA SURVEY DETACHMENTS (MSDs) AND MALARIA CONTROL DETACHMENTS (MCDs)*

Rank/Grade	Specialty (specialty code)	Number of men	
		MCD	MSD
Captain	Sanitary engineer (7960)	1	
Captain	Entomologist (3315)		1
Captain	Parasitologist (3310)		1
Technical Sergeant	Medical (673)	1	1
Staff Sergeant	Medical (673)		1
Staff Sergeant	Medical Laboratory Technician (858)		1
Sergeant	Sanitary Technician (196)	2	
**	Clerk (055)	1	1
	Medical Laboratory Technician (858)		2
	Sanitary Technician (196)	3	2
	Truck Driver, light (345)	3	3
	Utility Repairman (121)	1	

*summarized from Table of Organization and Equipment 8-50014

**ranks of the remainder were distributed among Technical Grades 4 and 5, Corporal, Private First Class and Private

These add up to 95 kinds of items and 550 individual pieces for MCDs and 53/232 for MSDs. Numbers for the specialized items further illustrate the complexity of the problem of supply. Unit equipment for an MSD (#9N108) comprises 237 kinds of items ranging from various acids and other reagents through glassware, dissecting instruments and microscopes. Amounts of items were calculated for a 60-day supply (13). There was the inevitable conflict with other services in procuring some of the specialized items. Stereomicroscopes, needed for mosquito identification and dissection, contain prisms and these are used also in binoculars, telescopes and other optical equipment. Special pleading was involved in procuring the optimal number of these (13).

It was necessary that both MSDs and MCDs be mobile because of the nature of their mission. Like field hospitals, they had to be able to follow the fighting men, often on short notice. It became clear early in the war that the more self-contained these units were, the faster they could be ready to pick up and go. To this end, it was recommended that the MSDs have a two-and-a-half-ton truck replace the weapons carrier. This recommendation had not made its way into the T/E summarized above. Such a truck already was in the T/E of MCDs. With a truck, along with a trailer and the three quarter-ton trucks (jeeps) already in the T/E, MSDs along with their MCD counterparts would be made independently mobile.

Packaging so much material was also a

TABLE 2EQUIPMENT FOR MALARIA SURVEY DETACHMENTS (MSDs) AND MALARIA CONTROL
DETACHMENTS (MCDs)*

Category	MCD**	MSD**
Chemical	3/56	3/25
Engineer	15/105	4/8
Medical		
Organizational***	2/3	3/3
Ordnance		
Miscellaneous	2/12	2/13
Vehicles	4/8	2/4
Motor transport equipment	7/40	5/17
Quartermaster		
Organization clothing	2/24	2/26
Individual equipment	7/49	7/54
Organization equipment	52/242	24/74
Signal	1/11	1/8

*summarized from Table of Organization and Equipment 8-50017

**quantities given as number of kinds/total pieces

***one item here was 'Unit equipment' (#9NO17 for MCD and #9N108 for MSD), which included a vast array of items of specialized nature

problem. Manageable units of compartmentalized packaging were needed which would allow repackaging to be done quickly and in such a way that items could be found quickly once work began in a new location. A letter from Medical Supply to The Surgeon General, 31 March 1943 (12) gives the result of packaging with these considerations in mind. Specialized material for MSDs was contained in 8 chests, 3 crates, 4 boxes and 1 drum. Material for MCDs was contained in 5 chests, 2 crates and 1 box. The letter recommends that, whenever possible, chests replace boxes.

Training of MSDs and MCDs

A 3-page directive, Mobilization Training Program (MTP) 8-21, was issued on 4 May

1943 (14). It was a bare outline, but it did specify subjects of study with hours to be devoted to each. It was based on the assumption that all personnel would have at least 8 weeks of basic training, in another unit, a Medical Replacement Training Center or a Medical Department Enlisted Technicians' School, before assignment to a malaria unit. Four weeks of instruction were to be given, eight hours per day, six days per week for a total of 192 hours as shown in Table 3. Other, more detailed schedules of the hour-by-hour program of instruction are highly specific. A training schedule for MSDs and MCDs at the Army Service Forces (ASF) Unit Training Center, New Orleans Port of Embarkation (no date given) takes up 72 pages (14). At least on paper, this schedule adds up to precisely the 192 hours prescribed

TABLE 3

TRAINING SCHEDULES FOR MALARIA SURVEY DETACHMENTS (MSDs) AND MALARIA CONTROL DETACHMENTS (MCDs)*

Topics requiring equal amounts of time for both MSDs and MCDs

	Hours
Dismounted drill	12
Physical training	12
Safeguarding military information	1
Introduction to malariology	8
Planning and control project	10
Use of survey/control equipment	27
Examination and inspections	8
Open time	16

Topics which either were different in the two kinds of unit or were allotted different total hours

	MSD	MCD
Introduction to parasitology	30	0
Methods of control	0	30
Introduction to entomology	12	8
Field trips	56	60

*summarized from Mobilization Training Program 8-2123

in MTP 8-21. In August 1943 a number of units, including both MSDs and MCDs, trained together there. The result was a saving of time, with the added advantage that friendships were established both among officers and among EM. This led to a greater readiness to cooperate when units were operating in the same areas overseas.

Location of operations of MSDs and MCDs and the specific tasks they accomplished

The war in the Pacific was divided into 4 geographic sections. The SWPA, the subject of this study, included Australia, the Malay

Archipelago east of Sumatra (from Java eastward to Timor), Borneo, the Moluccas (Celebes, Halmahera and others), New Guinea (and adjacent islands, including western Solomon Islands) and the Philippines. Detachments operated under one of three commands depending upon where their services were needed. Transfers from one command to another were not uncommon. For example, in a report from the Chief Surgeon, GHQ on 15 May 1944 (15), detachments had the following assignments: 5th Air Force, 2 MSD and 3 MCD; 6th Army, 6 MSD and 10 MCD; USASOS (US Army Services of Supply), 8 MSD and 14 MCD. The report notes that,

"...the Sixth Army Commander and the Commanding General, USASOS, are generously supplied with special purpose units [MSDs and MCDs], while the Commanding General, Fifth Air Force, has relatively few. The Surgeon, Fifth Air Force, informs me that he does not have sufficient special purpose units to control malaria... Recommend that the special service units recommended for the Fifth Air Force by the Chief Malariologist and concurred in by G-3, USAFFE, be approved." In apparent consequence, a redistribution of detachments can be seen in the report of 19 June 1944, just one month later. Here, detachments were distributed as follows: 5th Air Force - 4 MSD, 7 MCD; 6th Army - 8 MSD, 12 MCD; USASOS - 5 MSD, 9 MCD; unknown - 4 MSD, 2 MCD.

Men of both MSDs and MCDs were at times subject to possible injury or death due to enemy actions. These took the form of bombing, strafing, kamikaze attack, torpedoes directed at their ships, and a broaching of the defensive perimeter by infiltrators. In the Philippines, "Several of the units that landed early suffered minor casualties and Purple Hearts have been awarded." (16)

It is most unfortunate that the monthly unit reports of the MSDs and MCDs, which ranged throughout the SWPA, have not been located in NARA, nor have they been found elsewhere. They contain valuable biological information regarding the identity, distribution and abundance of mosquito species and the results of experiments relating to efforts to control them. They also contain information on rat control, dengue fever, mite control and miscellaneous other arthropod-related problems. From these reports one could also reconstruct the progression of sites where the units were located and how long they resided there. In partial compensation, extracts from unit reports found their way into the publication, *Malaria?*. For two years it was sent to, among others, malariologists, MSDs and MCDs. In addition, in October 1944, it was requested that reports from MSDs be sent in duplicate so that a copy might be given to Major Francisco Dy of the Philippines Civil Administration. One hopes that some of this information was of use to Philippines malariologists after the war. The following random sample of topics gives a sense of their variety:

- Results of a Survey of Native Laborers at ... Nadzab Area for Microfilariae.
- Observations on *Anopheles punctulatus moluccensis*.
- Japanese Malaria Regulations as Taken from Captured Documents.
- Experiments with DDT and Aircraft Spraying.
- Scrub Typhus Survey at Goodenough Island.

An extract from an MCD report gives quantitative estimates of work done in various kinds of control. These were ditching, brushing, oiling, ditch maintenance, clearing, filling and stream clearing. Both officers and EM were encouraged to publish results of their studies, but with restrictions on kinds of information, with directions on submitting through channels, and with specified format and composition (16).

The following summary of a monthly report from the 31st MSD provides an example of the kind of information these reports contain. It is from the report of 1 April 1945, when the detachment was at APO (Army Postal Office) 321, Mindoro Island, in the Philippines.

- 1) Following a general survey of the mosquito population, a series of 47 larval collecting stations was established. A chart shows the results of checking the larval populations between 2 and 21 March and a map, made by men in the detachment, shows their locations.
- 2) Two experiments with DDT were undertaken, one using emulsion, the other using dusting equipment.
- 3) Parasitological examination of 103 stool specimens from Filipinos yielded hookworm ova, *Entamoeba histolytica* trophozoites and blood fluke ova. Of 31 blood smears, 4 were positive for malaria parasites.

Though not in this report, it was also on Mindoro that rat collecting and preparation of rat museum-skins took place in relation to a study of scrub typhus.

By the time the first MCDs and MSDs

arrived in the South-West Pacific Area (February 1943), the war was progressing from the Solomons to New Guinea. Here, detachments served from Milne Bay near the southeast tip, and small islands nearby, to Sansapoor near the northwest tip and at many sites in between, following closely the fighting forces as they leapfrogged along the northeast coast. Detachments were also on the offshore island of Manus and by August 1944 were on the islands of Biak and Numfoor which lie, as one looks at a map of New Guinea, in the curved 'neck' of the bird-shaped New Guinea. By that date, both MSDs and MCDs were at Sansapoor. Tables 4 and 5 give the locations and movements of MSDs and MCDs during the period, September 1943 to June 1944. Time of unit arrivals at various places may have preceded the publication date of the periodically published listings of current locations found in Malaria Unit reports (15), from which the table was constructed. As the war shifted northward, MSDs and MCDs served on Morotai, a small island off the northeast coast of Halmahera, and then moved into the Philippines, working principally on the Islands of Leyte, Samar, Mindoro and Luzon. After that, operations moved out of the South-West Pacific Area to Okinawa and ultimately to Japan; in these places MSDs and MCDs continued their valuable support functions, if not against malaria, then against rodents, flies, mites, fleas, filarial worms and intestinal parasites, and performing sanitary inspections.

Operations of the 31st MSD

Given the apparent paucity of information regarding the various locations and activities of MSDs and MCDs, it is fortunate that it is available for the 31st MSD from my own memories and records and from a wartime journal kept by Robert M. Roecker, one of the other members of the detachment. The following is a detailed record of the locations and activities of the 31st MSD from its formation at Camp Harahan in New Orleans, Louisiana on 18 August 1943 to my departure from the unit in Japan on 23 November 1945.

Camp Harahan, 18 August-7 December 1943

Here, the normal complement of men forming the 31st MSD was assembled for the first time. The Commanding Officer, Captain Wayne Howe, was an entomologist. The

second in command, Lieutenant Malcolm K. Dulaney, was a virologist/epidemiologist. Of the six EM who would be doing the survey work, two were from the staff of the Sanitary Technicians' School in Camp Pickett, Virginia, and two others were from the last class there. The remaining two were from Laboratory Technicians' School. One of these six had a master's degree in biology, two had college undergraduate degrees in biology and one had two years of study toward a biology major. After the war, one officer, three of these men, and a replacement who joined the unit in February 1945, obtained PhDs in biology. Support for our mission was provided by a supply sergeant, a clerk and three driver/mechanics who operated our two jeeps, a weapons carrier and, later, a two-and-a-half-ton truck. One of the drivers especially was interested in the survey work and of his own volition was of considerable help in the field.

When the normal training period of four weeks was over, the group of MSDs and MCDs that trained together remained at Camp Harahan for what seemed an interminable period. I have not discovered what factors were involved, but for both EM and officers the post-training period was a time of frustration and boredom. The training itself varied in quality, but there were lectures on the biology of mosquitoes, the life cycle of the malaria parasite, and instruction in control procedures. Practical work involved identification of mosquito adults and larvae, dissection of mosquitoes, preparation of blood smears and mapping. There were day and night hikes, orientation exercises involving marching on a compass bearing through bayous, and night-time marches where a succession of check points had to be located. Survey and control units often were together in these training exercises.

Jackson Barracks, 7 December 1943-25 January 1944

Jackson Barracks, New Orleans, was a staging area where troops were assembled for shipment. It was another time of boredom and unproductivity.

En route, New Orleans to Milne Bay, New Guinea, 26 January-25 February 1944

The ship, the converted SS *Mexico*, had its decks enclosed and within, tiers of bunks

TABLE 4

LOCATION OF MALARIA SURVEY DETACHMENTS (MSDs) IN PAPUA NEW GUINEA,
SEPTEMBER 1943-JUNE 1944

MSD	Place	Period
4	Dobodura	Sep-Nov 1943
	Gusap	Dec 1943-Jun 1944
5	Kiriwina	Sep-Oct 1943
	Milne Bay	Oct-Dec 1943
	Finschhafen	Jan 1944
	Saidor	Jan-Jun 1944
6	Goodenough Island	Sep 1943-Jun 1944
17	Milne Bay	Sep 1943-Feb 1944
	Oro Bay	Feb-Jun 1944
24	Lae	Oct 1943-Jun 1944
26	Milne Bay	Dec 1943
	Oro Bay	Jan 1944
	Cape Gloucester	Jan-Jun 1944
27	Finschhafen	Apr-Jun 1944
28	Admiralties/Manus	Apr-Jun 1944
29	Milne Bay	Apr 1944
	Hollandia	Jun 1944
30	Milne Bay	Apr 1944
	Finschhafen	Jun 1944
31	Milne Bay	Feb-Apr 1944
	Finschhafen	Apr-Jun 1944
32	Nadzab	Feb-Jun 1944
34	Milne Bay	Feb-Jun 1944
	Admiralties	Jun 1944
37	Finschhafen	Apr 1944
	Lae	Jun 1944
38	Finschhafen	Jun 1944
39	Finschhafen	Apr-Jun 1944
40	Finschhafen	Apr-Jun 1944
41	Milne Bay	Feb-Jun 1944

TABLE 5

LOCATION OF MALARIA CONTROL DETACHMENTS (MCDs) IN PAPUA NEW GUINEA, SEPTEMBER 1943-JUNE 1944

MCD	Place	Period
4	Milne Bay	Sep 1943-Jun 1944
5	Oro Bay	Sep 1943-Jan 1944
	Cape Gloucester/Finschhafen	Jan-Jun 1944
6	Milne Bay	Sep-Oct 1943
	Oro Bay	Oct-Nov 1943
	Gusap	Dec 1943-Jun 1944
7	Kiriwina	Sep 1943-Jan 1944
	Finschhafen/Cape Cretin/Cape Gloucester	Feb-Jun 1944
8	Oro Bay	Sep 1943-Jun 1944
9	Cairns	Sep-Dec 1943
	Finschhafen	Jan-Jun 1944
10	Port Moresby	Sep 1943
	Lae	Oct 1943-Jun 1944
11	Milne Bay	Sep-Oct 1943
	Nadzab/Lae	Nov 1943-Jun 1944
12	Goodenough Island	Sep 1943-Apr 1944
	Finschhafen	May-Jun 1944
13	Dobodura	Sep 1943-Jan 1944
	Nadzab	Jan 1944
	Finschhafen	Feb-Jun 1944
14	Dobodura	Sep 1943-Jun 1944
15	Woodlark Island	Sep-Dec 1943
	Finschhafen	Jan 1944
	Saidor	Feb-Jun 1944
52	Milne Bay	Feb-Mar 1944
	Admiralties	Apr-Jun 1944

53	Milne Bay	Feb 1944
	Finschhafen	Feb-Jun 1944
54	Milne Bay	Feb-Mar 1944
	Goodenough Island	Apr-Jun 1944
55	Milne Bay	Feb-Mar 1944
	Goodenough Island	Apr-Jun 1944
56	Milne Bay	Feb-Mar 1944
	Finschhafen	Apr-Jun 1944
58	Milne Bay	Feb-Mar 1944
	Oro Bay	Apr-Jun 1944
59	Milne Bay	Feb 1944
	Oro Bay	Apr 1944
	Aitape	Jun 1944
60	Milne Bay	Feb 1944
	Cape Gloucester	Apr 1944
	Saidor	Jun 1944
61	Finschhafen	Apr-Jun 1944
62	Finschhafen	Apr-Jun 1944
63	Nadzab	May 1944
	Finschhafen	Jun 1944
64	Milne Bay	Apr-Jun 1944
65	Cape Gloucester	Jun 1944
67	Milne Bay	Feb-Apr 1944
	Oro Bay	May-Jun 1944
68	Milne Bay	Feb-Jun 1944
69	Milne Bay	Feb-Jun 1944
79	Finschhafen	Jun 1944

rose to the underside of the deck above. Several MSD and MCD units were aboard along with a construction outfit. The ship passed through the Panama Canal and stopped briefly for refueling at Bora Bora in the Society Islands.

Milne Bay, New Guinea, 25 February-8 April 1944

Here again, the 31st MSD was in a staging area, fed and housed in tents, part of the time by a service company, waiting for assignment to a place of work. With equipment in storage and with the Japanese long gone, personnel mostly swam in the ocean and hiked into the surrounding hills.

En route to Finschhafen, New Guinea, 8-11 April 1944

A makeshift shelter on the afterdeck of the Liberty ship, *Marcus Daly*, was constructed for sleeping. The ship carried a load of bombs in the hold.

Finschhafen, New Guinea, 11 April-10 September 1944

After 17 days of waiting for assignment to a specific area for a campsite from which to begin surveying, the 31st MSD arrived at Gusika Meadows, a few miles north of Finschhafen and finally went to work. Four pyramidal tents served as living quarters and a squad tent as office/laboratory. As soon as equipment was unpacked, mapping the assigned area began and mosquito larvae and adults were collected. With the extensive scientific literature brought with us, some of it our commanding officer's, we made our identifications, rearing larvae to adults if larval keys were not available. Two of us obtained biting records to ascertain the time of day when particular species of mosquitoes were biting most actively. Breeding sites were plotted on the maps which we ourselves prepared and printed (using blueprint paper) and monthly reports were sent to the appropriate higher echelons. We also had direct contact with nearby control units. Two EM conducted several classes for selected non-commissioned officers (NCOs) from surrounding units who became, one hoped, sources of information and discipline in their units.

Work was steady, but not oppressive and in time we could slow down or be free on

weekends. The equipment listed in our table of organization was well thought through and we had what was necessary. Base supply was able to resupply when needed. After 8 months (4 weeks of training, one month of transport, and the rest mostly interminable waiting) all 13 men worked here with a will during a stay of four and a half months.

Finschhafen to Hollandia, 10-21 September 1944

On 10 September the 31st MSD was flown to Hollandia, New Guinea, another staging area, in 6 C-47s in preparation for the move to Morotai. Hollandia was at that time in the Netherlands East Indies; it is now Jayapura, capital of the Papua Province (previously called Irian Jaya) of Indonesia.

Hollandia to Morotai, 21-27 September 1944

The 31st MSD travelled on Landing Ship, Tank (LST) 171 to Morotai, a small island off the northeast coast of Halmahera in the Moluccas or Spice Islands, now part of Indonesia.

Morotai, 27 September-10 November 1944

Initial landings had been made only six days before our arrival. A relatively small perimeter had been established, within which a former Japanese airfield was quickly enlarged and much used beginning 4 October in support of landings at Leyte in the Philippines. There was harassment by the Japanese in the form of bombing, strafing and infiltration through the perimeter by small groups. In consequence we finally were issued ammunition for the carbines we had received at Finschhafen. A large fly gave us a luxuriously accommodating lab/office and during our short stay of six weeks we efficiently accomplished our surveys and made our recommendations.

Morotai to Leyte, Philippine Islands, 10-15 November 1944

The 31st MSD travelled to Leyte on the USS *Almack*, an assault/cargo vessel, in what appeared to be a vast convoy. Before it was shot down, a Japanese plane released a torpedo which passed close by the stern of

a vessel just aft of us. We went ashore between the towns of Palo and Dulag.

Leyte Island, Philippines, 15 November 1944-2 January 1945

Leyte was to be for us just another staging area. Although the 31st MSD left Leyte on 2 January, another EM and I were placed on detached service and assigned to the 6th MCD, which left earlier on LST 1006 to be part of the convoy heading for the invasion of Mindoro Island. Mindoro was known to be highly malarious and it was forehanded to land a couple of survey men there immediately. The convoy departed on about the 12th and landings took place on 15 December. The trip was harassed by planes and dogfights were a daily occurrence. Also kamikaze pilots made some hits and as our LST was preparing to unload, a kamikaze plane heading for us was hit by gunfire and exploded. Once ashore, my unit mate and I did what survey work we could during the three weeks before the rest of the 31st MSD arrived, but we were somewhat hampered by lack of survey equipment.

Leyte to Mindoro, 2-7 January 1945

The 31st MSD made the short voyage on LST 737 and on arrival its full complement of men was reconstituted.

Mindoro Island, Philippines, 7 January-26 June 1945

The 31st MSD was in Mindoro longer than anywhere else. Encamped first in the furrowed land of a former sugar cane field near the coast, we later were a bit inland at a higher elevation where we settled into a routine of work, living in the relative luxury of wood floors for the tents, gravelled walkways and a generator permitting electric lights. In addition to the usual survey work, we experimented with stream clearing and flushing and with DDT, testing the effects of an emulsion dripped into a stream from a metal drum. We also participated in experiments with spraying DDT emulsion from a B-25, laying out on the ground squares of paper in a grid. Spots on the squares made by the oil in the emulsion gave an estimate of coverage. With scrub typhus a threat, we recommended the cutting and burning of the long grass surrounding campsites. Two of our EM had experience making museum

study skins of mammals, so here, as well as earlier on Morotai, we were able to make up over 50 skins of rodents, which along with their attached skulls were sent to the Smithsonian Institution for identification. Also included were mites (the transmitting agent of scrub typhus) scraped from the rodent's ears. Among the rodent specimens, Remington Kellogg described a new species, *Rattus morotaiensis* (from Morotai) and two new subspecies from Mindoro (*Chrotomys whiteheadi mindorensis* and *Rattus concolor solatus*). In February, one of our EM left by his request to be a chaplain's assistant and was replaced by a man with an undergraduate degree in biology. A lab technician was sent to Luzon in March to assist in venereal disease testing of prostitutes.

From 5 June to 20 June I was again placed on detached service to accompany a group on a three-week trip headed by Major George W. Hunter III. The purpose was to survey the east coast of Mindoro for evidence of schistosomiasis (blood fluke disease). The party consisted of Major Hunter, in charge, from the US Army Schistosomiasis Commission, Major Dillahunt from 165th Station Hospital, Captain Howard C. Dalton from the 310th Bombardment Wing, three EM including myself, the other two from the 8th MCD, and EM from an engineer battalion to operate the two Landing Craft, Mechanized (LCMs) used for transportation. A weapons carrier, loaded onto one of the LCMs, permitted travel on land. We examined over 200 stool specimens, finding as high as 20% positive in some barrios. Several areas were found to contain the very small (3 mm) snail intermediate host. Infection of snails was determined by crushing them (over 600), the infected ones being identified by their release of cercarial larvae.

Mindoro was occupied because of its level terrain on the relatively dry south coastal plain. Here two large airfields had been quickly constructed and by Christmas Eve army P-38s had been operating out of San Jose airfield. These planes served as support for the landings on Luzon (17). The men of the 31st MSD felt that by helping to maintain the health of the troops and flyers on Mindoro they were an important part of these vast operations. On 25 March 1945, the unit had orders to move, and loaded onto the Liberty ship, SS *Jeremiah O'Brien*, but

orders were changed and so the unit unloaded on 28 March and returned to survey work.

Mindoro to Okinawa, 26 June-9 July 1945

The voyage to Okinawa was in LST 793 and involved a brief stop in Subic Bay (Luzon). Some men erected a pyramidal tent on deck as a shelter, not all men having accommodations below.

Okinawa, 9 July-3 November 1945

As fighting forces island-hopped ever nearer to the Japanese homeland, service units moved up behind them, among these the 31st MSD. We landed near Nara and drove northward to our campsite on Bolo Point (also called Zampa Misaki or Cape Misaki) near the village of China and the airfield at Kadena. In addition to the usual antimalarial activities, it was clear that rats were a problem and that training was needed for this kind of control work. Therefore, two EM went to Rat Control School in Manila from 4 to 20 August. When they returned we were soon putting out poison baits and setting traps to determine effectiveness of kill. After the war ended we undertook or supervised insecticidal spraying of airplanes flying between Okinawa and Japan.

Okinawa to Japan, 3-7 November 1945

The 31st MSD travelled to Japan on Landing Ship, Medium (LSM) 227. With the war over, the trip was far less tense than the voyage to Mindoro had been.

Japan, 7-23 November 1945

The ship docked at Wakayama and we drove in a convoy to the outskirts of Osaka where we were quartered in a factory in a large room emptied of all its equipment. With our lab equipment unpacked we were able to examine faecal samples from Japanese food handlers employed by the military in order to look for intestinal parasites. This was the only work assigned to us up to the point of my leaving the 31st MSD on 23 November. Other unit members left in early December.

Summary view of the 31st MSD

The life span of the 31st MSD, counting from its formation in New Orleans to the time

of return home from Japan of the bulk of its original members, consisted of 829 days (2.3 years). In considering the various activities of the unit, this lifetime can be broken down as follows: training - 31 days (4%); travel - 67 days (8%); performing the work of the unit's mission - 484 days (58%); time lost in staging areas, waiting for assignment/transportation - 247 days (30%). The detachment served overseas for 21 months. The effectiveness of the officers and those field/laboratory men of the 31st MSD who were directly involved in its mission was due at least in part to their fascination with, dedication to and pre-military and military training in the subject of biology. This focus and training generated an enthusiasm which radiated through the entire detachment and resulted in a cohesive, smoothly functioning organization.

Discussion and Conclusions

Considering 12 reports per year from an average of perhaps 100 MSDs and MCDs in the South-West Pacific Area over a period of 3 years, and given the kinds of information contained in them, one has a sense of the amount of information they contained, information that I have not been able to obtain from either the Office of the Surgeon General or the National Archives and Records Administration and which apparently is lost. Therefore, after any such future operation there should be mechanisms in place to ensure that valuable scientific information not be lost, but be made available to the scientific community at large. Cataloguing and indexing are essential. It is equally clear that, with our knowledge of how the ravages of malaria greatly diminished the effectiveness of fighting men in the SWPA, instruction in malaria prevention and treatment be routinely given both to medical and line officers. It is also clear that for military preparedness it would be prudent for the military to conduct courses for both medical and line officers in the history of the debilitating effect of malaria on military operations and also on preventive measures. Thus it might be possible to prevent history from repeating itself. It would be equally important to determine the number of malariologists and MSDs and MCDs which are required and to organize their training. Finally, the military medical establishment should be constantly aware of developments in preventive measures against malaria and in its treatment.

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PUBLICATIONS OF RELEVANCE TO PAPUA NEW GUINEA AND MELANESIA

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1 Ashwell HE, Barclay L.

A retrospective analysis of a community-based health program in Papua New Guinea. *Health Promot Int* 2009 Jun;24(2):140-148. Epub 2009 Apr 2.

The Women and Children's Health Project was a large Australian funded aid Project that sought to improve the health of women and children in Papua New Guinea between 1998 and 2004. Community development and health promotion interventions aimed to increase community support for attended birth and children's health. Green and Kreuter's [Green, L. W. and Kreuter, M. W. (2005) *Health Program Planning: An Educational and Ecological Approach*, 4th edition. McGraw-Hill, New York] prece-de-proceed model of health program planning was applied retrospectively to critique the design, implementation and evaluation of the Project. An outcome evaluation (2006) provided data for this analysis and investigated long-term impact using a multi-methods approach. Application of the prece-de-proceed model was useful, but the model fails to sufficiently well identify 'inhibiting factors' as part of the educational and ecological assessment during the planning phase. Pre-defined objectives and contractually obligated outputs in a donor funded business model negatively influenced Project activity and outcomes. Despite this and the challenging context for implementation, Project interventions improved interaction between the community and health systems, and improved use of maternal child health services.

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A qualitative study on the acceptability and preference of three types of long-lasting insecticide-treated bed nets in Solomon Islands: implications for malaria elimination. *Malar J* 2009 Jun 4;8:119.

BACKGROUND: In March 2008, the Solomon Islands and Vanuatu governments raised the goal of their National Malaria Programmes from control to elimination. Vector control measures, such as indoor residual spraying (IRS) and long-lasting insecticidal bed nets (LLINs) are key integral components of this programme. Compliance with these interventions is dependent on their acceptability and on the socio-cultural context of the local population. These factors need to be investigated locally prior to programme implementation. **METHOD:** Twelve focus group discussions (FGDs) were carried out in Malaita and Temotu Provinces, Solomon Islands in 2008. These discussions explored user perceptions of acceptability and preference for three brands of long-lasting insecticide-treated bed nets (LLINs) and identified a number of barriers to their proper and consistent use. **RESULTS:** Mosquito nuisance and perceived threat of malaria were the main determinants of bed net use. Knowledge of malaria and the means to prevent it were not sufficient to

guarantee compliance with LLIN use. Factors such as climate, work and evening social activities impact on the use of bed nets, particularly in men. LLIN acceptability plays a varying role in compliance with their use in villages involved in this study. Participants in areas of reported high and year round mosquito nuisance and perceived threat of malaria reported LLIN use regardless of any reported unfavourable characteristics. Those in areas of low or seasonal mosquito nuisance were more likely to describe the unfavourable characteristics of LLINs as reasons for their intermittent or non-compliance. The main criterion for LLIN brand acceptability was effectiveness in preventing mosquito bites and malaria. Discussions highlighted considerable confusion around LLIN care and washing which may be impacting on their effectiveness and reducing their acceptability in Solomon Islands. **CONCLUSION:** Providing LLINs that are acceptable will be more important for improving compliance in areas of low or seasonal mosquito nuisance and malaria transmission. The implications of these findings on malaria elimination in Solomon Islands are discussed.

3 Bignault I, Bunde-Birouste A, Ritchie J, Silove D, Zwi AB.

Community perceptions of mental health needs: a qualitative study in the Solomon Islands. *Int J Ment Health Syst* 2009 Mar 13;3(1):6.

BACKGROUND: Psychosocial and mental health needs in the aftermath of conflict and disaster have attracted substantial attention. In the Solomon Islands, the conceptualisation of mental health, for several decades regarded by policy makers as primarily a health issue, has broadened and been incorporated into the national development and social policy agendas, reflecting recognition of the impact of conflict and rapid social change on the psychosocial wellbeing of the community as a whole. We sought to understand how mental health and psychosocial wellbeing were seen at the community level, the extent to which these issues were identified as being associated with periods of 'tension', violence and instability, and the availability of traditional approaches and Ministry of Health services to address these problems. **METHODS:** This article reports the findings of qualitative research conducted in a rural district on the island of Guadalcanal in the Solomon Islands. Key informant interviews were conducted with community leaders, and focus groups were held with women, men and young people. Wellbeing was defined broadly. **RESULTS:** Problems of common concern included excessive alcohol and marijuana use, interpersonal violence and abuse, teenage pregnancy, and lack of respect and cooperation. Troubled individuals and their families sought help for mental problems from various sources including chiefs, church leaders and traditional healers and, less often, trauma support workers, health clinic staff and police. Substance-related problems presented special challenges, as

there were no traditional solutions at the individual or community level. Severe mental illness was also a challenge, with few aware that a community mental health service existed. Contrary to our expectations, conflict-related trauma was not identified as a major problem by the community who were more concerned about the economic and social sequelae of the conflict. **CONCLUSION:** Communities identify and are responding to a wide range of mental health challenges; the health system generally can do more to learn about how this is being done, and build more comprehensive services and policy on this foundation. The findings underscore the need to promote awareness of those services which are available, to extend mental health care beyond urban centres to rural villages where the majority of the population live, and to promote community input to policy so as to ensure that it 'fits' the context.

4 **Bugni TS, Andjelic CD, Pole AR, Rai P, Ireland CM, Barrows LR.**

Biologically active components of a Papua New Guinea analgesic and anti-inflammatory lichen preparation. *Fitoterapia* 2009 Jul;80(5):270-273. Epub 2009 Mar 14.

A traditional preparation of *Parmotrema saccatilobum* (Taylor) Hale (Family: Parmeliaceae) is being considered for inclusion into the PNG national drug formulary by the Ministry of Health Taskforce on Traditional Medicines. The lichen preparation is traditionally used in the Milne Bay Province of Papua New Guinea for analgesic and anti-inflammatory activities. A hexane extract of *P. saccatilobum* yielded the principal components atranorin and chloroatranorin. Atranorin and chloroatranorin were tested in a COX-1 and -2 enzyme inhibition assay, which showed that atranorin inhibited COX-1 in a dose dependent manner and suggests partial inhibition by atranorin and chloroatranorin of COX-2 and COX-1, respectively.

5 **Chouvelon T, Warnau M, Churlaud C, Bustamante P.**

Hg concentrations and related risk assessment in coral reef crustaceans, molluscs and fish from New Caledonia. *Environ Pollut* 2009 Jan;157(1):331-340. Epub 2008 Jul 31.

There is a dramatic lack of data on Hg levels in marine organisms from tropical areas, and in particular from New Caledonia. For the first time, this study reports the total Hg concentrations in the tissues of several marine taxa from the New Caledonian lagoon. Seafood from both wild and farmed populations was considered. Hg concentrations varied over three orders of magnitude according to factors including species, age (size/weight), trophic level, lifestyle and geographical origin. Taking into account the edible tissues, estimations of the amount of flesh that should be consumed by a 60-kg person to reach the Hg Provisional Tolerable Weekly Intake (PTWI) reveal acceptable risk for human health in general. However, a risk was clearly identified in one site of the lagoon (i.e. Grande Rade) where high Hg concentrations were measured. These concentrations were higher than values reported in the current literature.

6 **Culverwell AD, Tapping CR.**

Congenital talipes equinovarus in Papua New Guinea: a difficult yet potentially manageable situation.

Int Orthop 2009 Apr;33(2):521-526. Epub 2008 Jan 15.

Reports in the literature have suggested a high incidence of congenital deformities, including congenital talipes equinovarus (CTEV), in many Pacific Islands. This study performed a retrospective analysis of cases of CTEV in an isolated region of Papua New Guinea over a 2-year period. Data were collected on the incidence of CTEV, together with an analysis of initial treatment and outcome. The incidence of CTEV was 2.7 per 1000 live births per year. A peak incidence of CTEV births in September suggested that maternal anaemia secondary to malaria was a significant risk factor. Good functional outcome was confirmed in only 20% of cases following initial treatment. The authors suggest the Ponseti method as a realistic option for treating CTEV in this region and that it could be instigated with minimal resources and training.

7 **Flueck C, Frank G, Smith T, Jafarshad A, Nebie I, Sirima SB, Olugbile S, Alonso P, Tanner M, Druilhe P, Felger I, Corradin G.**

Evaluation of two long synthetic merozoite surface protein 2 peptides as malaria vaccine candidates. *Vaccine* 2009 May 5;27(20):2653-2661. Epub 2009 Mar 6.

Merozoite surface protein 2 (MSP2) is a promising vaccine candidate against *Plasmodium falciparum* blood stages. A recombinant 3D7 form of MSP2 was a subunit of Combination B, a blood stage vaccine tested in the field in Papua New Guinea. A selective effect in favour of the allelic family not represented by the vaccine argued for a MSP2 vaccine consisting of both dimorphic variants. An alternative approach to recombinant manufacture of vaccines is the production of long synthetic peptides (LSP). LSP exceeding a length of well over 100 amino acids can now be routinely synthesized. Synthetic production of vaccine antigens cuts the often time-consuming steps of protein expression and purification short. This considerably reduces the time for a candidate to reach the phase of clinical trials. Here we present the evaluation of two long synthetic peptides representing both allelic families of MSP2 as potential vaccine candidates. The constructs were well recognized by human immune sera from different locations and different age groups. Furthermore, peptide-specific antibodies in human immune sera were associated with protection from clinical malaria. The synthetic fragments share major antigenic properties with native MSP2. Immunization of mice with these antigens yielded high titre antibody responses and monoclonal antibodies recognized parasite-derived MSP2. Our results justify taking these candidate polypeptides into further vaccine development.

8 **Garg KC, Kumar S, Madhavi Y, Bahl M.**

Bibliometrics of global malaria vaccine research. *Health Info Libr J* 2009 Mar;26(1):22-31.

OBJECTIVES: This study evaluates malaria vaccine research carried out in different parts of the world during 1972-2004 using different bibliometric indicators. **METHOD:** Data have been downloaded from PubMed for the period 1972-2004 using the keywords (malaria* or plasmodium or falciparum) and (vaccine*) in the title and abstract fields. The study examined the pattern of growth of the output,

its geographical distribution, profile of different countries in different subfields and pattern of citations using GOOGLE Scholar. **RESULTS:** Malaria vaccine research output is gradually increasing. The USA, followed by the UK and Australia contributed the highest number of papers. Publication activity has decreased in Switzerland and Sweden, but has increased in Brazil and China. The majority of the countries have focused on the development of asexual blood stage malaria. Citations per paper and incidence of high-quality papers for the USA, the UK, Papua New Guinea and Denmark are more than the average. The majority of the prolific institutions are located in the USA, the UK, France and Australia. **CONCLUSION:** The last two decades have witnessed considerable growth in research output in this field, while a successful malaria vaccine still remains elusive. Interestingly, the countries like the USA, the UK and Australia that lead in the quantity, quality and citation of this output are often not those directly affected by malaria.

9 Greene JA, Moormann AM, Vulule J, Bockarie MJ, Zimmerman PA, Kazura JW.

Toll-like receptor polymorphisms in malaria-endemic populations.

Malar J 2009 Mar 24;8:50.

BACKGROUND: Toll-like receptors (TLR) and related downstream signaling pathways of innate immunity have been implicated in the pathogenesis of *Plasmodium falciparum* malaria. Because of their potential role in malaria pathogenesis, polymorphisms in these genes may be under selective pressure in populations where this infectious disease is endemic. **METHODS:** A post-PCR ligation detection reaction-fluorescent microsphere assay (LDR-FMA) was developed to determine the frequencies of TLR2, TLR4, TLR9 and MyD88-adaptor-like protein (MAL) single nucleotide polymorphisms (SNPs), and TLR2 length polymorphisms in 170 residents of two regions of Kenya where malaria transmission is stable and high (holoendemic) or episodic and low, 346 residents of a malaria-holoendemic region of Papua New Guinea, and 261 residents of North America of self-identified ethnicity. **RESULTS:** The difference in historical malaria exposure between the two Kenyan sites has significantly increased the frequency of malaria-protective alleles glucose-6-phosphate dehydrogenase (G6PD) and hemoglobin S (HbS) in the holoendemic site compared to the episodic transmission site. However, this study detected no such difference in the TLR2, TLR4, TLR9 and MAL allele frequencies between the two study sites. All polymorphisms were in Hardy-Weinberg equilibrium in the Kenyan and Papua New Guinean populations. TLR9 SNPs and length polymorphisms within the TLR2 5' untranslated region were the only mutant alleles present at a frequency greater than 10% in all populations. **CONCLUSION:** Similar frequencies of TLR2, TLR4, TLR9 and MAL genetic polymorphisms in populations with different histories of malaria exposure suggest that these innate immune pathways have not been under strong selective pressure by malaria. Genotype frequencies are consistent with Hardy-Weinberg equilibrium and the neutral theory, suggesting that genetic drift has influenced allele frequencies to a greater extent than selective pressure from malaria or any other infectious agents in these populations.

10 Hamelin C, Salomon C, Sitta R, Gueguen A, Cyr

D, Lert F.

Childhood sexual abuse and adult binge drinking among Kanak women in New Caledonia.

Soc Sci Med 2009 Apr;68(7):1247-1253. Epub 2009 Feb 13.

The long-term consequences of violence against women are poorly documented within the context of political domination, economic inequalities and rapid social change of indigenous communities. Using data from the first population study on violence against women and their consequences on health in New Caledonia, South Pacific, this article investigates the association between childhood sexual abuse and binge drinking among 441 adult Kanak women. Face-to-face standardised interviews were conducted in 2002-2003, among women aged 18-54 years drawn from the electoral rolls. Childhood sexual abuse before 15 years of age was reported by 11.6% of respondents. Nearly all the perpetrators (96%) were known to the victims (63% being a close relative). The rate of frequent binge drinking amongst the women within the last 12 months was 34%. After controlling for social and demographic factors, an independent association was found between childhood sexual abuse and current binge drinking. This study is the first to analyse the contribution of childhood sexual abuse to the likelihood of later heavy alcohol use in an indigenous population in the South Pacific. The findings call for improving and giving priority to care for children who are victims of violence to prevent long-term health consequences and to develop prevention programs aimed at alcohol-related behaviour in women, while taking into account simultaneous individual and collective factors.

11 Hedges R, Rush E, Aalbersberg W.

Correspondence between human diet, body composition and stable isotopic composition of hair and breath in Fijian villagers.

Isotopes Environ Health Stud 2009 Mar;45(1):1-17.

The main aim of this work was to describe the relationship between diet, and hair and breath isotopic composition. From one Fijian rural village, hair and breath samples were procured from 20 women. Physical anthropometrics were made, and hair $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ and breath $^{13}\text{C}/^{12}\text{C}$ were measured. Individual diet diaries were kept for two of the four preceding weeks, and isotopic compositions of items which accounted for most of the diet were measured. Individual average diets were analysed for macronutrient and energy content and conform to reasonable nutritional expectation. Characteristics of the diet are described in terms of protein and energy, their patterning with respect to different clusters of food items and their relationship to individuals' anthropometry. Breath CO_2 is depleted in ^{13}C by 1-2 per thousand on average with respect to the total diet. Hair was enriched on average by 4.1 per thousand in nitrogen and 4.5 per thousand in carbon with respect to the total diet. There was insufficient population variation in hair isotopic composition to establish individual hair-diet isotopic differences. The definite relationship that we establish in this work, between dietary and tissue isotopic values for a human community, provides a basis for determining and validating dietary regimes more generally within non-industrial, non-global-'supermarket' economies.

12 Huppertz C, Capuano C, Palmer K, Kelly PM, Durrheim DN.

Lessons from the Pacific programme to eliminate lymphatic filariasis: a case study of 5 countries.

BMC Infect Dis 2009 Jun 12;9:92.

BACKGROUND: Lymphatic filariasis (LF) is an important neglected tropical disease, being a major cause of disability worldwide. The Global Programme to Eliminate Lymphatic Filariasis aims to eliminate LF as a public health problem by the year 2020, primarily through repeated Mass Drug Administration (MDA). The Pacific region programme commenced in 1999. By June 2007, five of the eleven countries classified as endemic had completed five MDA campaigns and post-MDA prevalence surveys to assess their progress. We review available programme data and discuss their implications for other LF elimination programs in developing countries. **METHODS:** Reported MDA coverage and results from initial surveys and post-MDA surveys of LF using the immunochromatographic test (ICT) from these five Pacific Island countries (Tonga, Niue, Vanuatu, Samoa and Cook Islands) were analysed to provide an understanding of their quality and programme progress towards LF elimination. Denominator data reported by each country programme for 2001 were compared to official sources to assess the accuracy of MDA coverage data. **RESULTS:** Initial survey results from these five countries revealed an ICT prevalence of between 2.7 and 8.6 percent in individuals tested prior to commencement of the programme. Country MDA coverage results varied depending on the source of denominator data. Of the five countries in this case study, three countries (Tonga, Niue and Vanuatu) reached the target prevalence of <1% antigenaemia following five rounds of MDA. However, endpoint data could not be reliably compared to baseline data as survey methodology varied. **CONCLUSION:** Accurate and representative baseline and post-campaign prevalence data are crucial for determining program effectiveness and the factors contributing to effectiveness. This is emphasised by the findings of this case study. While three of the five Pacific countries reported achieving the target prevalence of <1% antigenaemia, limitations in the data preclude identification of key determinants of this achievement.

- 13 **Johnson TA, Amagata T, Sashidhara KV, Oliver AG, Tenney K, Matainaho T, Ang KK, McKerrow JH, Crews P.**

The aignopsanes, a new class of sesquiterpenes from selected chemotypes of the sponge *Cacospongia mycofijiensis*.

Org Lett 2009 May 7;11(9):1975-1978.

A survey of individual specimens of northern Papua New Guinea derived *Cacospongia mycofijiensis* has yielded novel sesquiterpenes, aignopsanoic acid A (1), methyl aignopsanoate A (2), and isoaignopsanoic acid A (3). The structures and absolute configurations of 1-3 were established using NMR data, X-ray crystallography results, and an analysis of CD properties. Two of these metabolites, 1 and 2, were moderately active against *Trypanosoma brucei*, the parasite responsible for sleeping sickness.

- 14 **Karl S, Davis TM, St-Pierre TG.**

A comparison of the sensitivities of detection of *Plasmodium falciparum* gametocytes by magnetic fractionation, thick blood film microscopy, and RT-PCR.

Malar J 2009 May 11;8:98.

BACKGROUND: The magnetic properties of *Plasmodium*-infected erythrocytes have been exploited for different clinical and research purposes. A recent study in a rural clinical setting in Papua New Guinea has demonstrated that *Plasmodium falciparum* gametocyte detection is facilitated by magnetic deposition microscopy but no study has yet determined the relative sensitivity and limit of detection of a magnetic fractionation technique. The present study compares the detection limit and sensitivity of a technique based on the use of commercially available magnetic fractionation columns with those for thick blood film microscopy and reverse transcriptase polymerase chain reaction (RT-PCR) methods. **METHODS:** Gametocyte detection in six series of dilutions of cultured *P. falciparum* parasites with known gametocytaemia was conducted using magnetic fractionation, thick blood film, and RT-PCR techniques. **RESULTS:** The preparations obtained by the magnetic fractionation method were of thin film quality allowing easy gametocyte identification by light microscopy. Magnetic fractionation had a higher sensitivity and approximately two orders of magnitude better limit of detection than thick blood film microscopy. Gametocytes were also more readily detectable on the magnetically fractionated preparations. Magnetic fractionation had a similar limit of detection to that of RT-PCR. **CONCLUSION:** Magnetic fractionation is a highly sensitive and convenient method for gametocyte detection in comparison with the standard thick blood film and RT-PCR methods, and could readily be adapted to field application.

- 15 **Koepfli C, Mueller I, Marfurt J, Goroti M, Sie A, Oa O, Genton B, Beck HP, Felger I.**

Evaluation of *Plasmodium vivax* genotyping markers for molecular monitoring in clinical trials.

J Infect Dis 2009 Apr 1;199(7):1074-1080.

BACKGROUND: Many antimalarial interventions are accompanied by molecular monitoring of parasite infections, and a number of molecular typing techniques based on different polymorphic marker genes are used. Here, we describe a genotyping technique that provides a fast and precise approach to study *Plasmodium vivax* infection dynamics during circumstances in which individual clones must be followed over time. The method was tested with samples from an in vivo drug efficacy study. **METHODS:** The sizes of polymerase chain reaction fragments were evaluated by capillary electrophoresis to determine the extent of size polymorphism for 9 potential genetic markers (5 genes of merozoite surface proteins [msp] and 4 microsatellites) in 93-108 *P. vivax*-positive blood samples from 3 villages in Papua New Guinea. **RESULTS:** The microsatellites MS16 and Pv3.27 showed the greatest diversity in the study area, with 66 and 31 different alleles, respectively, followed by 2 fragments of msp1 and 2 other microsatellites; msp3alpha, msp4, and msp5 revealed limited polymorphism. **CONCLUSIONS:** Even for the most diverse markers, the highest allelic frequencies reached 6% (MS16) or 13% (Pv3.27). To reduce the theoretical probability of superinfection with parasites that have the same haplotype as that detected at baseline, we propose to combine at least 2 markers for genotyping individual *P. vivax* infections.

- 16 **Kulangara C, Kajava AV, Corradin G, Felger I.**

Sequence conservation in *Plasmodium falciparum* alpha-helical coiled coil domains proposed for vaccine development.

PLoS One 2009 May 25;4(5):e5419.

BACKGROUND: The availability of the *P. falciparum* genome has led to novel ways to identify potential vaccine candidates. A new approach for antigen discovery based on the bioinformatic selection of heptad repeat motifs corresponding to alpha-helical coiled coil structures yielded promising results. To elucidate the question about the relationship between the coiled coil motifs and their sequence conservation, we have assessed the extent of polymorphism in putative alpha-helical coiled coil domains in culture strains, in natural populations and in the single nucleotide polymorphism data available at PlasmoDB. **METHODOLOGY/PRINCIPAL FINDINGS:** 14 alpha-helical coiled coil domains were selected based on preclinical experimental evaluation. They were tested by PCR amplification and sequencing of different *P. falciparum* culture strains and field isolates. We found that only 3 out of 14 alpha-helical coiled coils showed point mutations and/or length polymorphisms. Based on promising immunological results 5 of these peptides were selected for further analysis. Direct sequencing of field samples from Papua New Guinea and Tanzania showed that 3 out of these 5 peptides were completely conserved. An in silico analysis of polymorphism was performed for all 166 putative alpha-helical coiled coil domains originally identified in the *P. falciparum* genome. We found that 82% (137/166) of these peptides were conserved, and for one peptide only the detected SNPs decreased substantially the probability score for alpha-helical coiled coil formation. More SNPs were found in arrays of almost perfect tandem repeats. In summary, the coiled coil structure prediction was rarely modified by SNPs. The analysis revealed a number of peptides with strictly conserved alpha-helical coiled coil motifs. **CONCLUSION/SIGNIFICANCE:** We conclude that the selection of alpha-helical coiled coil structural motifs is a valuable approach to identify potential vaccine targets showing a high degree of conservation.

17 Kunimitsu A.

The accuracy of clinical malaria case reporting at primary health care facilities in Honiara, Solomon Islands.

Malar J 2009 Apr 23;8:80.

BACKGROUND: The accuracy of malaria case reporting is challenging due to restricted human and material resources in many countries. The reporting often depends on the clinical diagnosis because of the scarcity of microscopic examinations. Particularly, clinical malaria case reporting by primary health care facilities (local clinics), which constitutes the baseline data of surveillance, has never previously been sufficiently evaluated. In order to improve the malaria reporting system to the level required to eventually eliminate this disease, this study estimates the gaps between the records of clinics and government statistics regarding the incidence of clinical malaria, and then also examines some factors that might explain the data discrepancy, including such variables as clinic staffing and record keeping. **METHODS:** All medical records for outpatients in 2007, handwritten by nurses, were collected from local clinics in Honiara, the capital of the Solomon Islands. The all-monthly clinical malaria

cases were then recalculated. The corresponding monthly data in official statistics were provided by the government. Next, in order to estimate any data discrepancy, the ratio of the cases recorded at clinics to the cases reported to the government was determined on the monthly basis. Finally, the associations between the monthly discrepancy and other variables were evaluated by a multiple regression analysis. **RESULTS:** The mean data discrepancy between the records of clinics and government statistics was 21.2% (n = 96). Significant associations were observed between the discrepancy and the average number of patients (coefficient: 0.05, 95%CI: 0.03, 0.07), illegible handwriting (coefficient: 0.09, 95%CI: 0.04, 0.15), the use of tally sheets (coefficient: -0.38, 95%CI: -0.54, -0.22), and the clinic level (coefficient: -0.48, 95%CI: -0.89, -0.06). **CONCLUSION:** The findings of this study demonstrate the huge data discrepancy between the records of clinics and government statistics in regard to clinical malaria case reporting. Moreover, the high numbers of patients, illegible writing, the disuse of tally sheets, and insufficient resources at some clinics are likely to be related to the increase in the discrepancy. The clinical malaria case reporting at the local clinic level therefore urgently needs improvement, in order to achieve better malaria surveillance and also to eventually eliminate this disease in the Solomon Islands.

18 Kurubi J, Vince J, Ripa P, Tefuarani N, Riddell M, Duke T.

Immune response to measles vaccine in 6 month old infants in Papua New Guinea.

Trop Med Int Health 2009 Feb;14(2):167-173. Epub 2009 Jan 17.

OBJECTIVE: To assess the efficacy of the current measles immunization schedule in Papua New Guinea, which is to give the first dose at 6 months of age and the second at 9 months. **METHODS:** Humoral immune response study of 140 Papua New Guinean infants at 6 months of age, measuring measles IgG antibodies by enzyme immunoassay before and 85 days after the 6-month dose of measles vaccine. **RESULTS:** After vaccination at 6 months, 35.7% of infants developed a level of measles antibodies consistent with protection (IgG >330 IU/ml); 17.7% had an antibody response (150-330 IU/ml) that is likely to afford some protection; 46.8% had no detectable antibody response (IgG <150 IU/ml). Among 53 infants with no antibody response, 37 (69.5%) developed an antibody response, while 42.4% (37/87) of those with maternal antibodies sero-converted (p = 0.002). **CONCLUSIONS:** Antibody response to measles vaccine was lower than expected at 6 months. While the presence of maternally derived antibodies accounted for some of the limited seroconversion in young infants, other factors are involved. Issues to be considered in determining the value of the first dose of measles vaccination in mid-infancy in poor countries are complex and antibody responses are only one factor. Others, such as cell-mediated immune responses, the non-specific protective effect of measles vaccine in preventing illness and death and the practicalities of uptake of vaccines at different ages, are also important.

19 Macfarlane JE, Alpers MP.

Treatment-seeking behaviour among the Nasioi people of Bougainville: choosing between traditional and western medicine.

Ethn Health 2009 Apr;14(2):147-168.

BACKGROUND: In Papua New Guinea (PNG) there continues to be considerable interest in developing a health system that incorporates both traditional and western medicine. A policy on traditional medicine has recently been endorsed. Simultaneously, there is limited information about the traditional beliefs and practices that influence treatment-seeking behaviour. **AIM OF THE STUDY:** A case study among the Nasioi people of Bougainville was conducted to gather information that could help to inform the implementation of the National Policy on Traditional Medicine for PNG. **RESEARCH OBJECTIVES:** The main objective of the case study was to describe how health knowledge and belief systems influence treatment-seeking behaviour, specifically in relation to the use of traditional and western health care systems. The study also sought to develop an explanatory model for decision-making responses to febrile illnesses and skin conditions. **METHODOLOGY:** By using a non-experimental, cross-sectional study design and focused ethnographic approach, a sample of 200 Nasioi community members were interviewed by Nasioi-speaking research assistants. **RESULTS:** The study found that people in the sample group subscribe to both traditional and western medical paradigms. Western medical concepts have been assimilated but have not displaced traditional understanding of illness. There was congruence between beliefs about causes of illness, treatment-seeking responses to illness and stated or hypothetical preferences for traditional or western medicine. Data obtained in each of these domains reflect concepts of illness derived from both medical paradigms and demonstrate participants' confidence in the efficacy of both traditional and western medicine. **CONCLUSIONS:** It is proposed that a health system that incorporates traditional medicine may be better aligned with people's concepts of illness than the current system. Because it is more consistent with Nasioi concepts of illness, an incorporated health system may lead to more appropriate health service utilisation and, ultimately, to improvements in population health status.

20 **Mathew AA, Keeffe JE, Le Mesurier RT, Taylor HR.**

Trachoma in the Pacific Islands: evidence from Trachoma Rapid Assessment. *Br J Ophthalmol* 2009 Jul;93(7):866-870. Epub 2009 Jan 27.

AIMS: To establish the presence or absence of trachoma in the Pacific Island region. **METHODS:** Trachoma Rapid Assessment methodology was used in Kiribati, Nauru, Vanuatu, Solomon Islands and Fiji. Advised by key informants, high-risk communities were chosen from each country. All available children aged 1-9 years and adults ≥ 40 years were examined. **RESULTS:** A total of 903 adults ≥ 40 years and 3102 children aged 1-9 years were screened at 67 sites. Rates of active trachoma in children were $>15\%$ in all sites in Kiribati and $>20\%$ in all sites in Nauru. However, there was a high variability of rates of active trachoma in survey sites in Vanuatu, Solomon Islands and Fiji with rates ranging from 0% to 43% (average 23.3%), 6.0% to 51.9% (average 30.5%) and 0% to 48.8% (average 22.1%) respectively. Average rates of scarring trachoma in adults were 61.9% in Kiribati, 12.5% in Nauru, 38.2% in Vanuatu, 67.0% in the Solomon Islands and 18.8% in Fiji. Rates of trichiasis and

trichiasis surgeries suggest the possibility of blinding trachoma in the region. **CONCLUSION:** The findings indicate that trachoma is present in all the Pacific Island countries screened. Further prevalence studies are required, and trachoma control measures should be considered.

21 **Mead S, Poulter M, Uphill J, Beck J, Whitfield J, Webb TE, Campbell T, Adamson G, Deriziotis P, Tabrizi SJ, Hummerich H, Verzilli C, Alpers MP, Whittaker JC, Collinge J.**

Genetic risk factors for variant Creutzfeldt-Jakob disease: a genome-wide association study. *Lancet Neurol* 2009 Jan;8(1):57-66. Comment in: *Lancet Neurol* 2009 Jan;8(1):25-26.

BACKGROUND: Human and animal prion diseases are under genetic control, but apart from *PRNP* (the gene that encodes the prion protein), we understand little about human susceptibility to bovine spongiform encephalopathy (BSE) prions, the causal agent of variant Creutzfeldt-Jakob disease (vCJD). **METHODS:** We did a genome-wide association study of the risk of vCJD and tested for replication of our findings in samples from many categories of human prion disease (929 samples) and control samples from the UK and Papua New Guinea (4254 samples), including controls in the UK who were genotyped by the Wellcome Trust Case Control Consortium. We also did follow-up analyses of the genetic control of the clinical phenotype of prion disease and analysed candidate gene expression in a mouse cellular model of prion infection. **FINDINGS:** The *PRNP* locus was strongly associated with risk across several markers and all categories of prion disease (best single SNP [single nucleotide polymorphism] association in vCJD $p=2.5 \times 10^{-17}$; best haplotypic association in vCJD $p=1 \times 10^{-24}$). Although the main contribution to disease risk was conferred by *PRNP* polymorphic codon 129, another nearby SNP conferred increased risk of vCJD. In addition to *PRNP*, one technically validated SNP association upstream of *RARB* (the gene that encodes retinoic acid receptor beta) had nominal genome-wide significance ($p=1.9 \times 10^{-7}$). A similar association was found in a small sample of patients with iatrogenic CJD ($p=0.030$) but not in patients with sporadic CJD (sCJD) or kuru. In cultured cells, retinoic acid regulates the expression of the prion protein. We found an association with acquired prion disease, including vCJD ($p=5.6 \times 10^{-5}$), kuru incubation time ($p=0.017$), and resistance to kuru ($p=2.5 \times 10^{-4}$), in a region upstream of *STMN2* (the gene that encodes SCG10). The risk genotype was not associated with sCJD but conferred an earlier age of onset. Furthermore, expression of *Stmn2* was reduced 30-fold post-infection in a mouse cellular model of prion disease. **INTERPRETATION:** The polymorphic codon 129 of *PRNP* was the main genetic risk factor for vCJD; however, additional candidate loci have been identified, which justifies functional analyses of these biological pathways in prion disease.

22 **Moodley Y, Linz B, Yamaoka Y, Windsor HM, Breurec S, Wu JY, Maady A, Bernhöft S, Thiberge JM, Phuanukoonnon S, Jobb G, Siba P, Graham DY, Marshall BJ, Achtman M.**

The peopling of the Pacific from a bacterial perspective. *Science* 2009 Jan 23;323(5913):527-530. Comment in: *Science* 2009 Jan 23;323(5913):467-468.

Two prehistoric migrations peopled the Pacific.

One reached New Guinea and Australia, and a second, more recent, migration extended through Melanesia and from there to the Polynesian islands. These migrations were accompanied by two distinct populations of the specific human pathogen *Helicobacter pylori*, called hpSahul and hspMaori, respectively. hpSahul split from Asian populations of *H. pylori* 31,000 to 37,000 years ago, in concordance with archaeological history. The hpSahul populations in New Guinea and Australia have diverged sufficiently to indicate that they have remained isolated for the past 23,000 to 32,000 years. The second human expansion from Taiwan 5000 years ago dispersed one of several subgroups of the Austronesian language family along with one of several hspMaori clades into Melanesia and Polynesia, where both language and parasite have continued to diverge.

- 23 **Mueller I, Widmer S, Michel D, Maraga S, McNamara DT, Kiniboro B, Sie A, Smith TA, Zimmerman PA.**

High sensitivity detection of *Plasmodium* species reveals positive correlations between infections of different species, shifts in age distribution and reduced local variation in Papua New Guinea.

Malar J 2009 Mar 11;8:41.

BACKGROUND: When diagnosed by standard light microscopy (LM), malaria prevalence can vary significantly between sites, even at local scale, and mixed species infections are consistently less common than expected in areas co-endemic for *Plasmodium falciparum*, *Plasmodium vivax* and *Plasmodium malariae*. The development of a high-throughput molecular species diagnostic assay now enables routine PCR-based surveillance of malaria infections in large field and intervention studies, and improves resolution of species distribution within and between communities. **METHODS:** This study reports differences in the prevalence of infections with all four human malarial species and of mixed infections as diagnosed by LM and post-PCR ligase detection reaction-fluorescent microsphere (LDR-FMA) assay in 15 villages in the central Sepik area of Papua New Guinea. **RESULTS:** Significantly higher rates of infection by *P. falciparum*, *P. vivax*, *P. malariae* and *Plasmodium ovale* were observed in LDR-FMA compared to LM diagnosis ($p < 0.001$). Increases were particularly pronounced for *P. malariae* (3.9% vs 13.4%) and *P. ovale* (0.0% vs 4.8%). In contrast to LM diagnosis, which suggested a significant deficit of mixed species infections, a significant excess of mixed infections over expectation was detected by LDR-FMA ($p < 0.001$). Age of peak prevalence shifted to older age groups in LDR-FMA diagnosed infections for *P. falciparum* (LM: 7-9 yrs 47.5%, LDR-FMA: 10-19 yrs 74.2%) and *P. vivax* (LM: 4-6 yrs 24.2%, LDR-FMA: 7-9 yrs 50.9%) but not *P. malariae* infections (10-19 yrs, LM: 7.7%, LDR-FMA: 21.6%). Significant geographical variation in prevalence was found for all species (except for LM-diagnosed *P. falciparum*), with the extent of this variation greater in LDR-FMA than LM diagnosed infections (overall, 84.4% vs. 37.6%). Insecticide-treated bednet (ITN) coverage was also the dominant factor linked to geographical differences in *Plasmodium* species infection prevalence explaining between 60.6% and 74.5% of this variation for LDR-FMA and 81.8%-90.0% for LM (except *P. falciparum*), respectively. **CONCLUSION:** The present study demonstrates that application of molecular diagnosis reveals

patterns of malaria risk that are significantly different from those obtained by standard LM. Results provide insight relevant to design of malaria control and eradication strategies.

- 24 **Myers WP, Myers AP, Cox-Singh J, Lau HC, Mokuai B, Malley R.**

Micro-geographic risk factors for malarial infection. *Malar J* 2009 Feb 13;8:27.

BACKGROUND: Knowledge of geography is integral to the study of insect-borne infectious disease such as malaria. This study was designed to evaluate whether geographic parameters are associated with malarial infection in the East Sepik Province of Papua New Guinea (PNG), a remote area where malaria is a major cause of morbidity and mortality. **METHODS:** A global positioning system (GPS) unit was used at each village to collect elevation, latitude and longitude data. Concurrently, a sketch map of each village was generated and the villages were sub-divided into regions of roughly equal populations. Blood samples were taken from subjects in each region using filter paper collection. The samples were later processed using nested PCR for qualitative determination of malarial infection. The area was mapped using the GPS-information and overlaid with prevalence data. Data tables were examined using traditional chi square statistical techniques. A logistic regression analysis was then used to determine the significance of geographic risk factors including elevation, distance from administrative centre and village of residence. **RESULTS:** Three hundred and thirty-two samples were included (24% of the total estimated population). Ninety-six were positive, yielding a prevalence of 29%. Chi square testing within each village found a non-random distribution of cases across sub-regions ($p < 0.05$). Multivariate logistic regression techniques suggested malarial infection changed with elevation (OR = 0.64 per 10 m, $p < 0.05$) and distance from administrative centre (OR = 1.3 per 100 m, $p < 0.05$). **CONCLUSION:** These results suggest that malarial infection is significantly and independently associated with lower elevation and greater distance from administrative centre in a rural area in PNG. This type of analysis can provide information that may be used to target specific areas in developing countries for malaria prevention and treatment.

- 25 **New England Journal of Medicine**

Antimalarial therapies in children from Papua New Guinea.

N Engl J Med 2009 Mar 19;360(12):1254; author reply 1255. Comment on: *N Engl J Med* 2008 Dec 11;359(24):2545-2557.

- 26 **O'Donnell A, Fowkes FJ, Allen SJ, Imrie H, Alpers MP, Weatherall DJ, Day KP.**

The acute phase response in children with mild and severe malaria in Papua New Guinea.

Trans R Soc Trop Med Hyg 2009 Jul;103(7):679-686. Epub 2009 May 5.

The production of acute phase proteins during infection is an important part of innate immunity and limits inflammation. However, little is known of the acute phase response in malaria. We measured acute phase proteins in plasma in children attending clinics and admitted to hospital with acute malaria in Papua New Guinea. Plasma ferritin concentration increased progressively with disease severity with markedly elevated levels in the most severely ill

children. Plasma ferritin was >500 ng/ml in 7/99 (7.1%) outpatients with uncomplicated malaria, 22/100 (22.0%) hospital non-severe cases, 64/175 (36.6%) severe malaria cases who survived and 7/9 (77.8%) severe malaria deaths ($p<0.001$). The greatest concentration of ferritin (3561 ng/ml) was observed in a child who died. By contrast, C-reactive protein concentration was markedly increased in 153 children with uncomplicated malaria [median 203 (interquartile range 51-365) microg/ml] but, surprisingly, was only moderately increased in 135 children with one or more severe manifestations of malaria [47 (17-97) microg/ml; $p<0.001$] and in 6 children who died [41 (22-280) microg/ml]. Excessive free-radical damage resulting from a combination of iron-induced oxidant stress and reduced levels of C-reactive protein may be an important pathological mechanism in severe malaria and amenable to therapeutic intervention.

27 Oman KM, Usher K, Moulds R.

Lack of coordination between health policy and medical education: a contributing factor to the resignation of specialist trainees in Fiji? *NZ Med J* 2009 Mar 13;122(1291):28-38.

AIM: Specialist training was established in Fiji in 1998. This study explored whether health policy, and in particular mismatches between existing policy and the new realities of local specialist training, contributed to decisions by many trainees to ultimately leave the public sectors, often to migrate. METHOD: Data were collected on the whereabouts of all specialist trainees. Semi-structured interviews were carried out with 36 of 66 Fiji trainees in order to explore reasons for continuing or not completing training, as well as the reasons behind subsequent career choices. RESULTS: Overall, 54.5% of doctors remained in the public sectors or were temporarily overseas. Completion of specialist training was particularly associated with improved retention. Policies that contributed to frustration and sometimes resignations included a lack of transparency in the selection of doctors to enter training pathways, and unreliable career progression following completion of training. Doctors who left training before completion mentioned family stresses, which were exacerbated by delayed age at entry into training and a lack of certainty in regards to the timing of improved working conditions through career advancement. CONCLUSION: Policy adjustments to expedite entry into training, as well as to establish predictable career progression as a reward for training may increase training completions and overall retention.

28 Pluess B, Mueller I, Levi D, King G, Smith TA, Lengeler C.

Malaria – a major health problem within an oil palm plantation around Popondetta, Papua New Guinea. *Malar J* 2009 Apr 8;8:56.

BACKGROUND: For companies operating in malaria-endemic countries, malaria represents a substantial risk to workers and their dependants, and can lead to significantly reduced worker productivity. This study provides an overview of the malaria epidemiology within an oil palm plantation in Popondetta, south-eastern Papua New Guinea, its implication for the company with its employees and their families and the potential for control. METHODS: In 2006, we carried out a cross-sectional study within six company villages, which included the determination of parasite rates by conventional

microscopy, interviews and haemoglobin measurements. Passive surveillance data were collected from the 13 company aid posts for the years 2005 and 2006. RESULTS: Malaria prevalence was found to be high: all-age prevalence was 33.5% (95% CI 30.1-37.0) in 723 individuals. *Plasmodium falciparum* was the dominant species, followed by *Plasmodium vivax* and *Plasmodium malariae*. Children between five and nine years of age were most affected (40.3%, 95% CI 0.32-0.49). Haemoglobin levels were found to be low: 11.0 g/dl (95% CI 10.8-11.1) for men and 10.4 g/dl (95% CI 10.3-10.5) for women, respectively. *Plasmodium falciparum* infections were significantly associated with anaemia (Hb < 10 g/dl). At the aid posts, all malaria cases in 2005 and January-March 2006 were diagnosed by symptoms only, while from April 2006 onwards most cases were tested by rapid diagnostic tests. Between 2005 and 2006, 22,023 malaria cases were diagnosed at the aid posts and malaria accounted for 30-40% of all clinical cases. Of the malaria cases, 13-20% were HOP employees. On average, an employee sick with malaria was absent for 1.8 days, resulting in a total of 9,313 workdays lost between 2005 and 2006. Sleeping outside of the house did not increase the risk of a malaria infection, neither did getting up before 7 am. CONCLUSION: Malaria was found to be a major health burden in the Higaturu Oil Palm plantation, posing a high risk for company staff and their relatives, including expatriates and other non-immune workers. Reducing the malaria risk is a highly recommended investment for the company.

29 Poespoprodjo JR, Fobia W, Kenangalem E, Lampah DA, Hasanuddin A, Warikar N, Sugiarto P, Tjitra E, Anstey NM, Price RN.

Vivax malaria: a major cause of morbidity in early infancy.

Clin Infect Dis 2009 Jun 15;48(12):1704-1712.

BACKGROUND: In areas where malaria is endemic, infants aged <3 months appear to be relatively protected from symptomatic and severe *Plasmodium falciparum* malaria, but less is known about the effect of *Plasmodium vivax* infection in this age group. METHODS: To define malaria morbidity in the first year of life in an area where both multidrug-resistant *P. falciparum* and *P. vivax* are highly prevalent, data were gathered on all infants attending a referral hospital in Papua, Indonesia, using systematic data forms and hospital computerized records. Additional clinical and laboratory data were prospectively collected from inpatients aged <3 months. RESULTS: From April 2004 through April 2008, 4976 infants were admitted to the hospital, of whom 1560 (31%) had malaria, with infection equally attributable to *P. falciparum* and *P. vivax*. The case-fatality rate was similar for inpatients with *P. falciparum* malaria (13 [2.2%] of 599 inpatients died) and *P. vivax* malaria (6 [1.0%] of 603 died; $p=0.161$), whereas severe malarial anemia was more prevalent among those with *P. vivax* malaria (193 [32%] of 605 vs. 144 [24%] of 601; $p=0.025$). Of the 187 infants aged <3 months, 102 (56%) had *P. vivax* malaria, and 55 (30%) had *P. falciparum* malaria. In these young infants, infection with *P. vivax* was associated with a greater risk of severe anemia (odds ratio, 2.4; 95% confidence interval, 1.03-5.91; $p=0.041$) and severe thrombocytopenia (odds ratio, 3.3; 95% confidence interval, 1.07-10.6; $p=0.036$) compared with those who have *P. falciparum* infection. CONCLUSIONS: *P. vivax* malaria is a major cause

of morbidity in early infancy. Preventive strategies, early diagnosis, and prompt treatment should be initiated in the perinatal period.

- 30 **Robinson LJ, D'Ombrain MC, Stanisic DI, Taraika J, Bernard N, Richards JS, Beeson JG, Tavul L, Michon P, Mueller I, Schofield L.**

Cellular tumor necrosis factor, gamma interferon, and interleukin-6 responses as correlates of immunity and risk of clinical *Plasmodium falciparum* malaria in children from Papua New Guinea.

Infect Immun 2009 Jul;77(7):3033-3043. Epub 2009 Apr 20.

The role of early to intermediate *Plasmodium falciparum*-induced cellular responses in the development of clinical immunity to malaria is not well understood, and such responses have been proposed to contribute to both immunity and risk of clinical malaria episodes. To investigate whether *P. falciparum*-induced cellular responses are able to function as predictive correlates of parasitological and clinical outcomes, we conducted a prospective cohort study of children (5 to 14 years of age) residing in a region of Papua New Guinea where malaria is endemic. Live, intact *P. falciparum*-infected red blood cells were applied to isolated peripheral blood mononuclear cells obtained at baseline. Cellular cytokine production, including production of interleukin-2 (IL-2), IL-4, IL-6, IL-10, tumor necrosis factor (TNF) (formerly tumor necrosis factor alpha), and gamma interferon (IFN-gamma), was measured, and the cellular source of key cytokines was investigated. Multicytokine models revealed that increasing *P. falciparum*-induced IL-6 production was associated with an increased incidence of *P. falciparum* clinical episodes (incidence rate ratio [IRR], 1.75; 95% confidence interval [CI], 1.20 to 2.53), while increasing *P. falciparum*-induced TNF and IFN-gamma production was associated with a reduced incidence of clinical episodes (IRR for TNF, 0.55 [95% CI, 0.38 to 0.80]; IRR for IFN-gamma, 0.71 [95% CI, 0.55 to 0.90]). Furthermore, we found that monocytes/macrophages and gammadelta-T cells are important for the *P. falciparum*-induced production of IL-6 and TNF. Early to intermediate cellular cytokine responses to *P. falciparum* may therefore be important correlates of immunity and risk of symptomatic malaria episodes and thus warrant detailed investigation in relation to the development and implementation of effective vaccines.

- 31 **Salih S, Tedd H, Gillmer M.**
Screening for gestational diabetes mellitus in an indigenous Melanesian population on the islands of Vanuatu.
J Obstet Gynaecol 2009 Feb;29(2):98-100.

We set out to estimate the incidence of gestational diabetes mellitus (GDM) in the indigenous Melanesian population of Vanuatu by administering a 50 g oral glucose load to 120 women attending antenatal clinics at Vila Central Hospital, Efate, Vanuatu. Capillary blood glucose was measured 60 min later, and participants with a reading >7.8 mmol/l (140 mg/dl) were referred for further investigation to the local consultant obstetrician. Nine women (7.5%) had blood glucose readings of >7.8 mmol/l. Of the known risk factors for GDM, age was significantly higher in the group with abnormal 1 h readings. This screening method suggests that the incidence of GDM in the indigenous Melanesian population of Vanuatu is

lower than that of Melanesians living in Western environments, although our findings may be attributable to differences in the glucose loading test used and the sampling technique.

- 32 **Salim L, Ang A, Handali S; Cysticercosis Working Group in Papua, Tsang VC. Collaborators: Nenobais AM, Mirino YJ, Ap YR, Oemar R, Kawulur HS, Sandy S, Widiyanti M, Ayomi I, Natalia EI, Lumbanradja E, Raharjo M, Fitriana E, Kelyanin YG, Bilangla'bi' J.**

Seroepidemiologic survey of cysticercosis-taeniasis in four central highland districts of Papua, Indonesia. *Am J Trop Med Hyg* 2009 Mar;80(3):384-388.

Cysticercosis and taeniasis are known to be present in Papua, Indonesia. Several small studies have found a high prevalence of cysticercosis (23.5-56.9%) in the central highlands of Papua. A seroepidemiologic survey was carried out in four districts (Jayawijaya, Paniai, Pegunungan Bintang, and Puncak Jaya) of Papua. Anti-cysticercosis and anti-taeniasis antibodies were measured in 2,931 people using recombinant T24 and recombinant ES33 as a measure of cysticercosis and taeniasis exposures, respectively. Prevalence of cysticercosis-taeniasis is high in the Jayawijaya and Paniai districts (20.8% and 29.2% for cysticercosis and 7% and 9.6% for taeniasis, respectively) and lowest in the other two districts (Pegunungan Bintang and Puncak Jaya) (2% and 2% for cysticercosis and 1.7% and 10.7% for taeniasis, respectively). Our data show that the prevalence of cysticercosis and taeniasis are unchanged from that reported nearly 35 years ago at the beginning of cysticercosis-taeniasis epidemics in Papua, Indonesia.

- 33 **Stanisic DI, Richards JS, McCallum FJ, Michon P, King CL, Schoepflin S, Gilson PR, Murphy VJ, Anders RF, Mueller I, Beeson JG.**

Immunoglobulin G subclass-specific responses against *Plasmodium falciparum* merozoite antigens are associated with control of parasitemia and protection from symptomatic illness.

Infect Immun 2009 Mar;77(3):1165-1174. Epub 2009 Jan 12.

Substantial evidence indicates that antibodies to *Plasmodium falciparum* merozoite antigens play a role in protection from malaria, although the precise targets and mechanisms mediating immunity remain unclear. Different malaria antigens induce distinct immunoglobulin G (IgG) subclass responses, but the importance of different responses in protective immunity from malaria is not known and the factors determining subclass responses in vivo are poorly understood. We examined IgG and IgG subclass responses to the merozoite antigens MSP1-19 (the 19-kDa C-terminal region of merozoite surface protein 1), MSP2 (merozoite surface protein 2), and AMA-1 (apical membrane antigen 1), including different polymorphic variants of these antigens, in a longitudinal cohort of children in Papua New Guinea. IgG1 and IgG3 were the predominant subclasses of antibodies to each antigen, and all antibody responses increased in association with age and exposure without evidence of increasing polarization toward one subclass. The profiles of IgG subclasses differed somewhat for different alleles of MSP2 but not for different variants of AMA-1. Individuals did not appear to have a propensity to make a specific subclass response irrespective of the antigen. Instead, data suggest that subclass responses to each antigen are generated

independently among individuals and that antigen properties, rather than host factors, are the major determinants of IgG subclass responses. High levels of AMA-1-specific IgG3 and MSP1-19-specific IgG1 were strongly predictive of a reduced risk of symptomatic malaria and high-density *P. falciparum* infections. However, no antibody response was significantly associated with protection from parasitization per se. Our findings have major implications for understanding human immunity and for malaria vaccine development and evaluation.

- 34 **Steer AC, Kado J, Jenney AW, Batzloff M, Waqatakiwewa L, Mulholland EK, Carapetis JR.** Acute rheumatic fever and rheumatic heart disease in Fiji: prospective surveillance, 2005-2007. *Med J Aust* 2009 Feb 2;190(3):133-135.

OBJECTIVES: To determine the incidence and clinical features of acute rheumatic fever (ARF) in Fiji, and the clinical features of patients presenting to hospital in Fiji with rheumatic heart disease (RHD). **DESIGN AND SETTING:** A prospective surveillance study at the Colonial War Memorial Hospital in Suva over a 23-month period from December 2005 to November 2007. **MAIN OUTCOME MEASURES:** Incidence of ARF; clinical features of ARF and RHD. **RESULTS:** The average annualised incidence of definite cases of ARF in children aged 5-15 years was 15.2 per 100,000 (95% CI, 9.0-22.6). The clinical features of ARF were similar to those in classic descriptions. Carditis was very common, occurring in 79% of cases. There were 103 admissions for RHD in which detailed information was collected, with the most common reason for admission being cardiac failure (51%). The median age at admission with RHD was 26.8 years, and there were 10 deaths of patients with RHD (case fatality rate, 9.7%). **CONCLUSIONS:** Although apparently declining in incidence since the middle of the 20th century, ARF remains a significant health problem in Fiji. RHD affects young people, leading to premature morbidity and mortality. There is an urgent need for effective control of ARF and RHD in Fiji.

- 35 **Steer AC, Jenney A, Kado J, Good MF, Batzloff M, Waqatakiwewa L, Mulholland EK, Carapetis JR.**

Prospective surveillance of invasive group A streptococcal disease, Fiji, 2005-2007. *Emerg Infect Dis* 2009 Feb;15(2):216-222.

We undertook a prospective active surveillance study of invasive group A streptococcal (GAS) disease in Fiji over a 23-month period, 2005-2007. We identified 64 cases of invasive GAS disease, which represents an average annualised all-ages incidence of 9.9 cases/100,000 population per year (95% confidence interval [CI] 7.6-12.6). Rates were highest in those >65 years of age and in those <5 years, particularly in infants, for whom the incidence was 44.9/100,000 (95% CI 18.1-92.5). The case-fatality rate was 32% and was associated with increasing age and underlying coexisting disease, including diabetes and renal disease. Fifty-five of the GAS isolates underwent emm sequence typing; the types were highly diverse, with 38 different emm subtypes and no particular dominant type. Our data support the view that invasive GAS disease is common in developing countries and deserves increased public health attention.

- 36 **Taylor WR, Widjaja H, Basri H, Ohrt C, Taufik T,**

Tjitra E, Baso S, Fryauff D, Hoffman SL, Richie TL.

Changes in the total leukocyte and platelet counts in Papuan and non-Papuan adults from north-east Papua infected with acute *Plasmodium vivax* or uncomplicated *Plasmodium falciparum* malaria. *Malar J* 2008 Dec 18;7(1):259.

BACKGROUND: There are limited data on the evolution of the leukocyte and platelet counts in malaria patients. **METHODS:** In a clinical trial of chloroquine vs chloroquine plus doxycycline vs doxycycline alone against *Plasmodium vivax* (n=64) or *Plasmodium falciparum* (n=98) malaria, the total white cell (WCC) and platelet (PLT) counts were measured on Days 0, 3, 7 and 28 in 57 indigenous Papuans with life-long malaria exposure and 105 non-Papuan immigrants from other parts of Indonesia with limited malaria exposure. **RESULTS:** The mean Day 0 WCC (n=152) was 6.492 (range 2.1-13.4) $\times 10^9/L$ and was significantly lower in the Papuans than in the non-Papuans: 5.77 $\times 10^9/L$ vs 6.86 $\times 10^9/L$ D = -1.09 [95% CI -0.42 to -1.79 $\times 10^9/L$, p=0.0018]. 14 (9.2%) and 9 (5.9%) patients had leukopenia (<4.0 $\times 10^9/L$) and leukocytosis (>10.0 $\times 10^9/L$), respectively. By Day 28, the mean WCC increased significantly (p=0.0003) from 6.37 to 7.47 $\times 10^9/L$ (73 paired values) and was similar between the two groups. Ethnicity was the only WCC explanatory factor and only on Day 0. The mean Day 0 platelet count (n=151) was 113.0 (range 8.0-313.0) $\times 10^9/L$ and rose significantly to 186.308 $\times 10^9/L$ by Day 28 (p<0.0001). There was a corresponding fall in patient proportions with thrombocytopenia (<150 $\times 10^9/L$): 119/151 (78.81%) vs 16/73 (21.92%, p<0.00001). Papuan and non-Papuan mean platelet counts were similar at all time points. Only malaria species on Day 0 was a significant platelet count explanatory factor. The mean D0 platelet counts were significantly lower (p=0.025) in vivax (102.022 $\times 10^9/L$) vs falciparum (122.125 $\times 10^9/L$) patients. **CONCLUSIONS:** Changes in leukocytes and platelets were consistent with other malaria studies. The Papuan vs non-Papuan difference in the mean Day 0 WCC was small but might be related to the difference in malaria exposure.

- 37 **Utsumi T, Lusida MI, Yano Y, Nugrahaputra VE, Amin M, Juniastuti, Soetjipto, Hayashi Y, Hotta H.**

Complete genome sequence and phylogenetic relatedness of hepatitis B virus isolates in Papua, Indonesia.

J Clin Microbiol 2009 Jun;47(6):1842-1847. Epub 2009 Apr 22.

Each hepatitis B virus (HBV) genotype and subgenotype is associated with a particular geographic distribution, ethnicity, and anthropological history. Our previous study showed the novel HBV subgenotypes C6 (HBV/C6) and D6 (HBV/D6), based on the S gene sequences of isolates in Papua, Indonesia. The present study investigated the complete genome sequence of 22 strains from Papua and subjected them to molecular evolutionary analysis. A phylogenetic analysis revealed that 9 out of 22 strains were classified as HBV/C6, 3 strains as HBV/D6, and 9 strains as HBV/B3. A particular strain positioned between HBV/B3 and HBV/B5 remained unclassifiable into any known subgenotypes. This strain showed high homology with HBV/C5 from the Philippines in the core region and was thought to have undergone genetic recombination with HBV/C5. Further studies are

needed to determine whether this strain belongs to a new subgenotype of HBV/B. Based on the amino acid alignment, HBV/C6 has subgenotype specific variations (G18V and V47M) in the S region. HBV/C6 strains were more closely related in terms of evolutionary distance to strains from the east Asia and Pacific regions than those found in southeast Asia. HBV/D6 strains were most closely related to strains from the Western countries (HBV/D3) rather than those from Asia and Papua New Guinea. In conclusion, we have confirmed by complete sequence analysis that two novel HBV subgenotypes, HBV/C6 and HBV/D6, are prevalent in Papua, Indonesia.

- 38 **van den Biggelaar AH, Richmond PC, Pomat WS, Phuanukoannon S, Nadal-Sims MA, Devitt CJ, Siba PM, Lehmann D, Holt PG.**

Neonatal pneumococcal conjugate vaccine immunization primes T cells for preferential Th2 cytokine expression: a randomized controlled trial in Papua New Guinea. *Vaccine* 2009 Feb 25;27(9):1340-1347. Epub 2009 Jan 14.

The effects of neonatal immunization with 7-valent pneumococcal conjugate vaccine (7vPCV) on development of T-cell memory and general immune maturation were studied in a cohort of Papua New Guinean newborns. Neonatal 7vPCV priming (followed by a dose at 1 and 2 months of age) was associated with enhanced Th2, but not Th1, cytokine responses to CRM₁₉₇ compared to 7vPCV at 1 and 2 months of age only. T cell responses to non-7vPCV vaccine antigens were similar in all groups, but TLR-mediated IL-6 and IL-10 responses were enhanced in 7vPCV vaccinated compared to controls.

Neonatal 7vPCV vaccination primes T cell responses with a polarization towards Th2 with no bystander effects on other T cell responses.

- 39 **Wootton R, Menzies J, Ferguson P.**

Follow-up data for patients managed by store and forward telemedicine in developing countries.

J Telemed Telecare 2009;15(2):83-88.

There is very little published information about the outcomes of patients treated by telemedicine in developing countries. Over a two-year period, seven medical students from five universities spent their electives at a hospital in Papua New Guinea. They assisted with the review of a total of 44 e-referrals made by local doctors; the referrals resulted in 61 queries in a wide range of specialties. The major categories of these queries were internal medicine, paediatrics and surgery. Follow-up data were obtained in 22 of the 44 cases (50%) after a median period of 13 weeks (interquartile range 3-19). The cases were reviewed by an independent doctor. Telemedicine was considered to have assisted with the diagnosis in all cases (median score 5 on a five-point scale from 1 = not helpful at all to 5 = very good/excellent). The advice to the referring doctor for further action was considered helpful in all except one case (median score 5 on the same scale). The outcome for the patient was considered to be good in 15 of the cases (median score 4 on the same scale). Medical students were able to facilitate e-referrals by relieving the pressure on the local doctor to undertake the necessary clerical and technical work. The students reported a rewarding elective experience. The follow-up data showed that low-cost telemedicine can provide useful advice in a low resource setting.

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INFORMATION FOR AUTHORS

The Papua New Guinea Medical Journal invites submission of original papers and reviews on all aspects of medicine. Priority will be given to articles and subjects relevant to the practice of medicine in Papua New Guinea and other countries in the South Pacific.

Manuscripts are accepted for publication only with the understanding that they have not been published nor submitted for publication elsewhere. All manuscripts will be sent out for referees' comments as part of the peer review process.

Original Articles: Reports of original and new investigations or contributions.

Brief Communications and Case Reports: Contents similar to that of original articles but text should be no more than a total of 4 Journal pages including all figures and tables.

Reviews: Critical analysis of previously collected and published information.

Letters: Short reports of clinical experience or topics of interest. Text should not exceed 2 pages of the Journal.

Other types of manuscript may also be accepted for publication at the Editor's discretion.

Submitted manuscripts should conform to the instructions set out below. Manuscripts not conforming to these instructions will be returned.

MANUSCRIPTS

Submit the original with a virus-free electronic copy on disk as a word document or send by email to the Editorial Office. All sections including text, references, tables and legends, should be in double spacing. Manuscripts should not be right justified. Each paper should include an informative Summary, Introduction, Patients/Materials and Methods, Results, Discussion and References. The title page should include the title, full names of all authors, names and addresses of institutions where the work has been done and full present address of the first or corresponding author.

References should be kept to a minimum, and must be in the Vancouver style. Authors should check all references against the original source. Sample references are shown below.

- 3 **Garner PA, Hill G.** Brainwashing in tuberculosis management. *PNG Med J* 1985;28:291-293.
- 4 **Cochrane RG.** A critical appraisal of the present position of leprosy. In: Lincicome DP, ed. *International Review of Tropical Medicine*. New York: Academic Press, 1961:1-42.

ILLUSTRATIONS

Tables and figures should be prepared on separate pages. Figures should be sent as separate jpeg or tiff images. Do not paste the images into Word. Photographs should be glossy prints, either 7 cm or 14.5 cm in width. Photomicrographs should have internal scale markers. Each table should have a heading and footnotes which make it understandable without reference to the text. Each figure should have a legend; figure legends should be typed together on a separate sheet.

Abbreviations: Standard abbreviations and units should be used.

Drug Names: Generic names of drugs should be used.

Orthography: The Shorter Oxford English Dictionary is followed.

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CONTENTS

EDITORIAL

- An integrated approach to malaria control in Papua New Guinea *M.W. Hetzel* 1

ORIGINAL ARTICLES

- Reference values for pulse oximetry in healthy children in coastal Papua New Guinea *M. Laman, P. Ripa, J.D. Vince and N. Tefuarani* 8
- Predictors of HIV testing and serostatus amongst children admitted to Port Moresby General Hospital *W.E. Allison, M. Kiromat, J.D. Vince, M. Schaefer and J. Kaldor* 13
- Thiamine (vitamin B1) status of boarding school students in the Southern Region of Papua New Guinea *P. Temu, V.J. Temple, A. Saweri and W. Saweri* 21
- Outbreak of nosocomial sepsis in the Special Care Nursery at Port Moresby General Hospital due to multiresistant *Klebsiella pneumoniae*: high impact on mortality *A.E. Lithgow and C. Kilalang* 28
- The role of HIV social research in the response efforts to the HIV epidemic in Papua New Guinea *A. Kelly* 35
- Common themes in the literature on traditional medicine in Papua New Guinea *J. Macfarlane* 44

MEDICAL HISTORY

- Malaria survey and malaria control detachments in the South-West Pacific Area in World War 2 *D.W. Crocker* 54

MEDLARS BIBLIOGRAPHY

69