



# The Australian Childhood Immunisation Register—A model for universal immunisation registers?

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## ABSTRACT

The Australian Childhood Immunisation Register (ACIR) was established in 1996 as an opt-out register built on the platform of Medicare, the universal national health insurance scheme. Introduction of financial incentives for providers and parents, linked to the ACIR, followed from 1998. Over the subsequent decade, national levels for receipt of all vaccines by 12, 24 and 72 months of age have risen to 91%, 93%, and 88%, respectively. Conscientious objection to immunisation can be registered, with retention of eligibility for incentives. The ACIR has been important in implementation of a range of measures to improve childhood immunisation coverage in Australia. Linkage of a universal childhood immunisation register to national health insurance schemes has potential applicability in a variety of settings internationally.

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## 1. Background

The Australian Childhood Immunisation Register (ACIR) was the first complete purpose-built national childhood immunisation register in the world. It commenced operation in 1996, using the Australian universal health insurance scheme, Medicare, as a platform, replacing an ad hoc group of regional registers and periodic national household surveys [1]. The ACIR now contains immunisation records for over 5.8 million children and 44 million immunisation encounters from over 21,000 immunisation providers and is linked to a range of incentive payments for parents [2,3] and providers [4]. There have been three unpublished external reviews of the ACIR conducted over the past 10 years and one peer-reviewed publication summarising its operation and development [5]. This paper presents an overview of the development of the ACIR and examines its applicability to immunisation registries elsewhere.

## 2. Scope and definition of immunisation registers

Immunisation registers have been defined as confidential, population-based, computerised information systems containing identified data sent directly by providers of immunisation [6,7]. When additional capabilities, such as adverse event reporting, vaccine management, or linkages with other electronic databases, are

added to a register, it is designated an immunisation information system (IIS) [8].

Accurate information on the immunisation status of children is needed both at the individual and population level. Coverage data at the regional, jurisdictional and national level is needed for planning and delivery of immunisation programs and targeting of specific geographic areas or populations. At the individual level, combining immunisation records from multiple providers allows accurate assessment of whether a child requires an immunisation, enables issuing of recall and reminder letters, and facilitates opportunistic immunisation [9].

## 3. Immunisation registers in other countries

### 3.1. United States

Minimum functional standards for immunisation registries in the United States (US) were adopted by the National Immunization Program in 2001 [10]. The US Healthy People 2010 initiative includes an objective of 95% participation of children <6 years of age with two or more immunisations recorded on a US immunisation registry [11]. However, in 2000, a survey of registry funding indicated that only 24% of children <6 years were enrolled on a registry, increasing to 56% in 2005 [11].

### 3.2. United Kingdom

The Cover of Vaccination Evaluated Rapidly (COVER) program was first piloted in England and Wales in January 1987 and, by May

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1989, 175 of 200 districts in England and Wales were participating, yielding vaccination data for quarterly cohorts of resident children for sentinel antigens. Since 2002, COVER data are collected in England using primary care trusts as the denominator, based on registration with general practitioners (GPs) and area of residence [12]. The objectives of the COVER program are to: improve vaccination coverage by providing program coordinators with timely comparative information; encourage the development and dissemination of quarterly reports within districts; standardise measurement criteria and thereby facilitate the enhancement of existing software; rapidly detect local and national changes in vaccination coverage; and investigate through ad hoc enquiries possible reasons for poor performance.

### 3.3. New Zealand

The National Immunisation Register (NIR) of New Zealand is a computerised information system maintaining immunisation data for New Zealand children, with phased national implementation commencing in 2004/05 [13]. The five major practice management system software programs used by primary health care providers in New Zealand were enhanced to interface with the NIR [13]. Maternity facilities and maternity carers send information on newborns directly to the NIR. Migrant children and children born to New Zealand citizens overseas, whose date of birth falls within the birth cohort, are registered at their first point of contact with primary health care services. After an immunisation event, the information (and any changes to the child's demographic information) is sent to the NIR.

### 3.4. Denmark

Since April 1968, all Danish residents have been given a unique identification number in the Danish Civil Registration System (CRS). The CRS number acts as a key to recorded information in national registries and facilitates linkages between individuals and relevant information in all registries [14]. Information on the vaccination history of children can be obtained from one of these registries, the Danish Childhood Vaccination Database. GPs administer all childhood vaccinations in Denmark and receive reimbursement for reporting vaccinations to the National Health Insurer. One of the valuable characteristics of the linkages among Danish health-related registers that use the CRS number is that it is possible to conduct large prospective cohort studies of vaccine-effectiveness and safety [14].

## 4. The Australian Childhood Immunisation Register

Prior to the establishment of the ACIR, a number of registers operated in an ad hoc and variable manner across Australia, with the population served often difficult to ascertain [15]. Given the decentralised nature of immunisation provision in the Australian health care system, a national register was seen as the only way to accurately record immunisation status across local and state/territory boundaries. The initial objectives of the ACIR were to enable the Commonwealth, States and Territories to better manage immunisation programs and to increase coverage rates, to interrupt disease transmission, to enable providers and parents to determine a child's immunisation status in real time, to develop recall-reminder systems, and to provide national coverage data at regular intervals by age, vaccine and region, for program management and targeted immunisation efforts.

The ACIR was established on January 1, 1996, by transferring data on all children <7 years of age enrolled in Medicare, to the register [5]. Participation in the ACIR is opt-out, and can be considered a nearly complete population register as it is estimated

that 99% of children resident in Australia are registered with Medicare by 12 months of age and children not enrolled in Medicare can be added to the ACIR via a supplementary number [5]. By 2 years of age, the ACIR records exceed official population estimates [16], so although there may be some multiple registrations, the number of children not accounted for is likely to be very small. Child records are transferred nightly from the Medicare database to the ACIR. Immunisation data is sent to the ACIR by a recognised immunisation provider through a number of channels; via Medicare Australia's Internet site, through practice management software applications, and paper forms which can be mailed to the ACIR. The proportion of providers sending notifications to the ACIR online has steadily increased over time from 6% in 1998 to 65% in 2007, with a further 5% notifying by other electronic means. In 2001, after discovering that 14% of immunisations not notified to the ACIR were given overseas [17,18], the ACIR legislation was amended to allow these immunisations to be recorded, if a provider endorsed their validity. The existence of medical contraindications and conscientious objection to immunisation is also recorded. All vaccination records for a child remain on the register but no new records are added after the seventh birthday. The number of vaccinations recorded on the ACIR per year has increased from 3.3 million in 1996 to 4.9 million in 2005, reflecting increased numbers of vaccines on the National Immunisation Program schedule, allowances to record immunisation given overseas, and increases in the number of providers notifying immunisations, especially since GP incentives were introduced in 1998.

Immunisations recorded on the Register must be rendered in accordance with the guidelines issued by the National Health and Medical Research Council as stated in *The Australian Immunisation Handbook* [19]. Notifications falling outside these guidelines or duplicate notifications prompt an enquiry with the provider and if their validity cannot be established, they are rejected. From the data entered onto the ACIR, Medicare Australia sends parents/guardians a copy of their child's immunisation history statement at milestone ages and on request, and provides identified, de-identified and statistical data to approved providers and health administrators.

### 4.1. ACIR provider and parent incentives

The number and range of provider and parental immunisation incentives is unique to Australia and linkage of the ACIR to Medicare allows efficient administration. GPs administer the majority of immunisations in Australia (e.g., 71% in 2007). The General Practice Immunisation Incentives (GPII) scheme provides three types of direct and indirect payments to GPs [4]. These are a Service Incentive Payment (SIP) payable for reporting the completion of age appropriate vaccinations for children <7 years, an Outcomes Payment to practices that achieve 90% immunisation coverage of the children attending the practice and infrastructure funding for organisations providing support to GPs at the local and national level [20]. An information payment of up to A\$6 is made to all immunisation providers (not just physicians), who notify the ACIR of a vaccination that completes one of the age-based schedules. In 2007, the total amount paid to providers for information payments was approximately A\$8 million and payments have remained constant since 1998. In contrast, total SIP and outcome payments to GPs increased substantially from July 1998 to June 2001, and have remained stable since, at around A\$40 million.

In 1998, an international precedent was set when Australia introduced a nationwide scheme of financial immunisation incentives for parents [21]. Federal law requires parents either provide evidence that their child is age-appropriately immunised or send a completed form documenting approved medical, religious or philosophical exemptions, in order to receive two government-funded payments, the maternity immunisation allowance (MIA) and the

**Table 1**  
Immunisation coverage (%) by age group and vaccine, Australia, 2007.

Age group	Number of children	DTP	Polio	Hib	Hep B	MMR	Fully immunised
12 months	277,933	92.0	91.9	94.5	94.4	n/a	91.3
24 months	268,300	95.1	95.1	94.4	95.9	94.1	92.7
72 months	266,841	89.1	89.1	n/a	n/a	89.1	88.4

child care benefit (CCB) [2,3]. The MIA was means-tested until 2004 [2] and is currently set at A\$233, payable at 18–24 months of age if all immunisations due at or before 18 months have been received or a medical or philosophical exemption applies. To encourage timeliness of immunisation, a parent must apply for the MIA before their child's second birthday. In the 12 months from July 2004 to June 2005, A\$43 million was paid to parents for the MIA [22]. The CCB assists parents who use specific types of child care and are employed, seeking employment or studying, with eligibility requiring either documentation of full immunisation or an approved exemption [3]. The payment ranges from A\$28–\$169 per week per child, depending on the type of child care used, family income and the number of children in the household. Parents using the specified care are eligible for the minimum payment irrespective of income [3].

#### 4.2. Measuring immunisation coverage using the ACIR

The cohort method was adopted for calculating coverage at the population level (national and state/territory) [23] since the ACIR's inception, with each cohort defined by date of birth in 3-month age groups. Cohort immunisation status is assessed at the three key milestones: 12 months of age (for vaccines due at 6 months); 24 months of age (for vaccines due at 12 months); and 6 years of age (for vaccines due at 4–5 years). A minimum 3-month lag period is allowed for late notification of immunisations to the Register, but only immunisations given on or before a child's first, second or sixth birthday are considered. If a child's records indicate that the child received the last dose of a vaccine that requires >1 dose to complete the series, it is assumed that earlier vaccinations in the sequence have been given. This assumption has been shown to be valid [24,25].

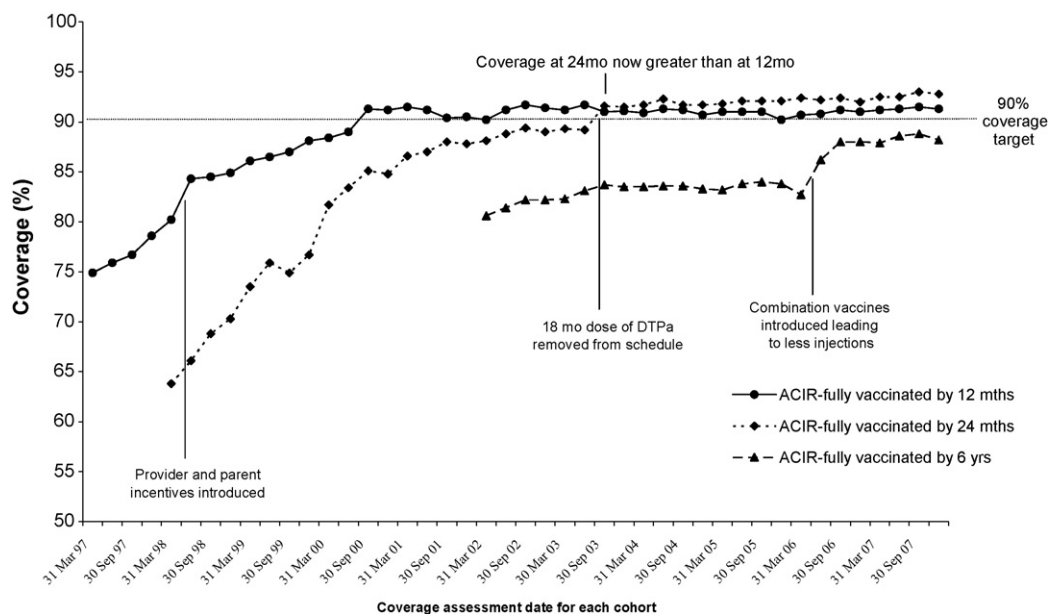
The proportion of children designated as “fully immunised” is calculated with Medicare-registered children who have completed

the primary schedule as the numerator and the total number of Medicare-registered children in the age cohort as the denominator. “Fully immunised” at 12 months of age is defined as a child having a record on the ACIR of three doses of a diphtheria (D), tetanus (T) and pertussis-containing (P) vaccine, three doses of polio vaccine, two or three doses of *Haemophilus influenzae* type b (Hib) vaccine, and two or three doses of hepatitis B vaccine. “Fully immunised” at 24 months of age is defined as a child having a record on the ACIR of three doses of a DTP-containing vaccine, three doses of polio vaccine, three or four doses of Hib vaccine, two or three doses of hepatitis B vaccine, and one dose of a measles, mumps and rubella-containing (MMR) vaccine. “Fully immunised” at 72 months of age is defined as a child having a record on the ACIR of four doses of a DTP-containing vaccine, four doses of polio vaccine, and two doses of an MMR-containing vaccine.

#### 4.3. Coverage estimates

The 2007 coverage estimates for the three milestone ages of 12 months, 24 months and 6 years are provided in Table 1. “Fully immunised” coverage and coverage for all individual vaccines for the 12 and 24-month age groups are greater than the Immunise Australia Program's target of 90%. However, recorded coverage for the 6-year (72 month) age group is approaching, but still below the target.

Fig. 1 shows the trends in “fully immunised” vaccination coverage for all three milestone ages from the first ACIR-derived published coverage estimates in 1997–2007. There is a clear trend of increasing vaccination coverage over time for children of all age groups assessed, with the two youngest age cohorts having the highest coverage. Coverage at 24 months of age exceeded that at 12 months of age for the first time at the end of 2003 and has remained higher since. This is likely related to the removal of the requirement for an 18-month dose of DTP for full immunisation, as well as the introduction of immunisation incentives. Increasing coverage



**Fig. 1.** Trends in “fully immunised” immunisation coverage at 12, 24 and 72 months of age, Australia.

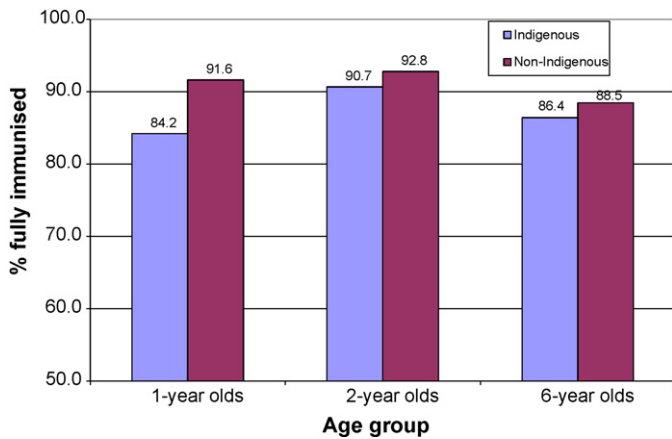


Fig. 2. “Fully immunised” coverage by age and Indigenous status, Australia, 2007.

rates for the 72-month cohort in recent years coincides with the introduction of combination vaccines leading to fewer injections. Coverage of individual vaccines mirrors the fully immunised trends but exceeds them for some vaccines, especially those requiring only one dose.

Coverage estimates can now be calculated by Indigenous status, as completeness of Indigenous status recording on the ACIR has progressively improved, from 42% of the estimated national cohort of Indigenous children aged 12–14 months in 2002 to 95% in 2005 [26]. It was estimated that this had increased to 99% by 2007 [27]. Vaccination coverage estimates for the three milestone ages by Indigenous status are shown in Fig. 2 and reveal that in 2007 coverage is lower for Indigenous children than non-Indigenous for all three ages, with the difference in coverage being greatest at 12 months of age. This difference in coverage at 12 months of age has been relatively consistent for the past 6 years.

#### 4.4. Timeliness of immunisation

The most widely accepted indicator of the performance of immunisation programs globally is the proportion of children

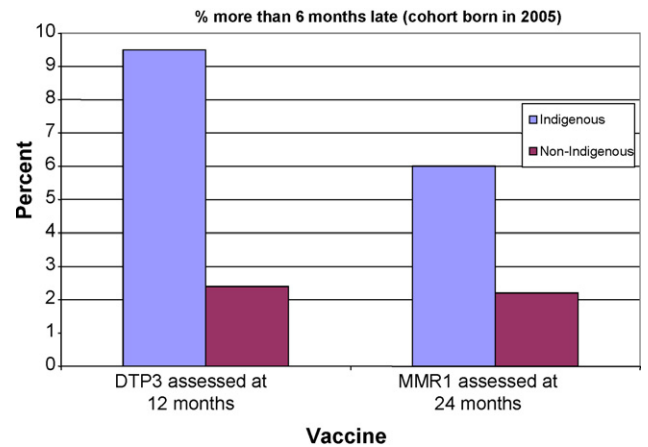


Fig. 3. Proportion of children >6 months late for their immunisations by Indigenous status, Australia, 2007.

receiving all recommended vaccines by 24 months of age [28]. However, this does not capture delay in receipt of immunisation. Timeliness is an important public health goal, as a number of vaccine preventable diseases such as invasive disease due to Hib, *Streptococcus pneumoniae* or *Bordetella pertussis*, particularly impact young infants. Although vaccination coverage has increased in Australian children between 1998 and 2007 from 88% to 92%, there has been no substantial change in timeliness [28]. Delayed immunisation is more marked for Indigenous compared with non-Indigenous children, especially for immunisations due by 12 months of age. By 24 months of age this disparity decreases somewhat (Fig. 3).

#### 4.5. Small area coverage reporting including maps of immunisation coverage

Although “fully immunised” coverage at the national level by 24 months of age was 92% for children born between the 1 July and 30 September 2004, several regions within the country have

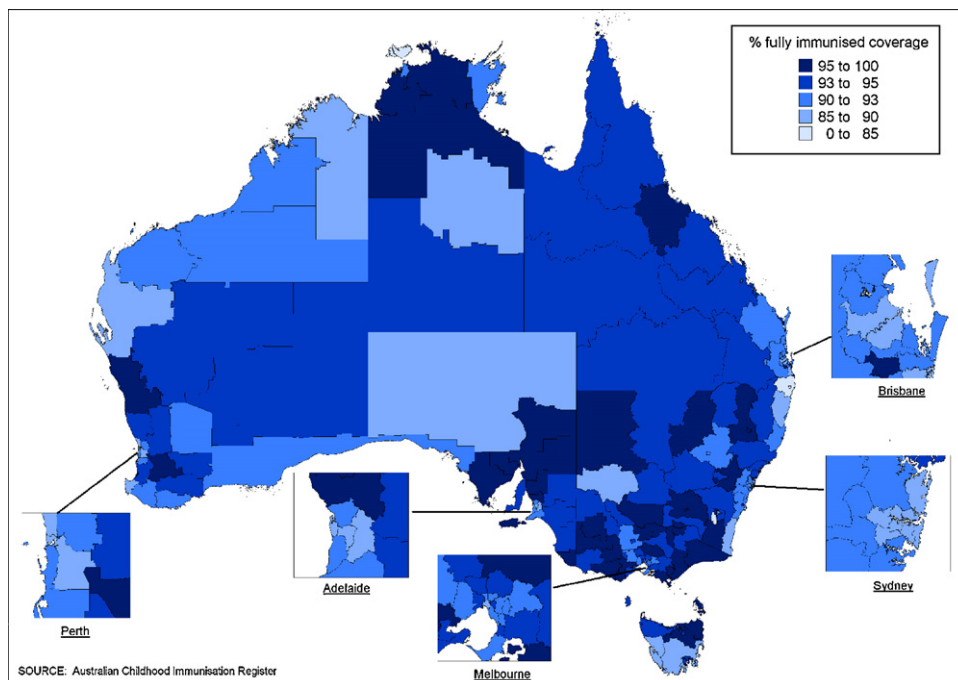


Fig. 4. “Fully immunised” coverage at 24 months of age by Statistical Sub-Division, Australia, 2006.

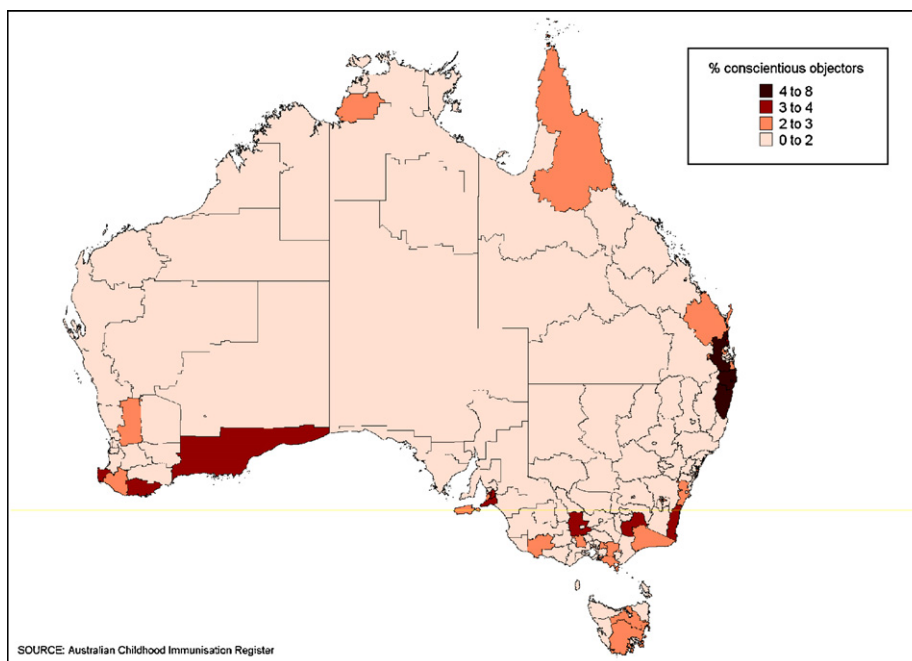


Fig. 5. Proportion of official conscientious objectors to immunisation, Australia, 2006.

substantially lower coverage (Fig. 4). Coverage maps have consistently shown pockets of low coverage, both in metropolitan and rural regions [29]. Coverage estimates by region are important for targeting local interventions to improve immunisation coverage [30,31].

#### 4.6. Conscientious objectors to immunisation

An important feature of the ACIR is that it records registered conscientious objectors to immunisation. Parents with a personal, philosophical, religious or medical belief that their child should not be immunised must see a medical practitioner to complete a conscientious objection form in order to retain eligibility for parental incentives. Low coverage is associated with a high proportion of conscientious objectors which ranges from 0 to 8% by statistical sub-division, with an average of 1.2% (Fig. 5).

## 5. Discussion

Since its inception, the ACIR has grown to hold records for over 5.8 million children and receives reports from over 21,000 providers of immunisation services. The functionality of the ACIR has been enhanced over time following the recommendations of reviews in 1997, 2000 and 2003 such that it now has many of the features of an “ideal” immunisation register, including enrolment at birth, a unique personal identifier, information on vaccine dose, date and provider, and mechanisms for aggregating data regionally and nationally [32].

The main alternative to an immunisation register is a periodic cross-sectional survey. These can be conducted by telephone, such as occurs with the American National Immunization Survey (NIS), which is of sufficient size to estimate immunisation coverage rates for children aged 19 to 35 months in all 50 states in the US [33], or by personal interview at the household level, such as the surveys conducted by the Bureau of Statistics which preceded the ACIR in Australia. One question about coverage estimates derived from the ACIR is how much of the change demonstrated over time was attributable to higher vaccination rates versus higher reporting.

A household survey replicating previous methodology was conducted in Australia in 2001 [34] and comparison with estimates from previous surveys [1,34] confirmed that coverage for pertussis-containing vaccines had increased substantially, whereas there was only a modest increase for vaccines such as MMR given as a single dose at 12 months of age. In contrast, comparing coverage estimates for the three milestone ages of 12, 24 and 72 months from the 2001 survey with contemporaneous estimates from the ACIR showed similar estimates at 12 months of age, but increasing divergence at 24 and 72 months of age, consistent with diminishing parental recall and availability of records over time.

The US NIS uses provider confirmation of parental report which was not done in the Australian household surveys [33]. Coverage estimates from the 2005 NIS and 2006 ACIR for DTP and one dose of MMR at 24 months of age were 96.1% versus 95.1% and 91.5% versus 93.9%, respectively. The ACIR tends to under-estimate coverage [18,35] due to incomplete provider reporting, whereas the NIS will tend to over-estimate coverage due to inherent biases of telephone-based methodologies. In 2001 it was estimated that the ACIR underestimated coverage by 2.7–5.0%, with the degree of underestimation greater for the 24 months compared with the 12-month age group [18]. In 2002, a survey conducted in an inner city area of Sydney of 162 children identified as being overdue for immunisations through ACIR found that only 37% were actually overdue. Failure of providers to notify immunisation encounters, migration and failure to record overseas vaccination were the main reasons for children having incomplete immunisation [36]. It is important to note that since 2001, electronic notification by providers has increased by 45%.

An advantage of surveys such as the NIS is that a wide variety of socio-demographic information about children and their parents can be collected. The only socio-demographic data collected by the ACIR is the age, sex and Indigenous status of the child, limiting the scope of immunisation coverage research which can be undertaken using ACIR-derived data. In addition, surveys can collect data on persons of any age, which is important as immunisation programs are increasingly targeting adolescents and adults. In contrast, the ACIR currently only captures children <7 years of age, limiting

assessment to young children. The NIS collected provider-reported vaccination information for adolescents aged 13–17 years for the first time in 2006 [37].

A strength of the ACIR is that it can be considered to be a census of Australian children <7 years rather than a sample of the target population, as used in survey methodology. Children not captured by the ACIR may differ in their immunisation rate. However as an estimated 99% of children are captured by the ACIR through Medicare, and non-registered children can still be notified to the ACIR, any such difference should have a very small overall impact on coverage rates. It may have a more measurable impact in urban areas with large immigrant populations.

The completeness of the register at any time point is dependent on provider notification, but does not depend on parental recall and data can be available relatively quickly. Over time there has also been an increasing proportion of providers reporting electronically, resulting in less notification delay, however further improvements are possible, as there are still approximately 30% of providers not reporting electronically. Registries which only allow electronic notification may have less notification delay, however this may be at the expense of completeness if there are a substantial number of providers not using electronic communication.

The accuracy of immunisation status as recorded on the ACIR at both the individual and regional level has improved substantially in the same time frame as the introduction of financial incentives to parents and providers. The latter group of incentives predominantly applies to GPs, who represent the majority of providers in Australia (71%). The only payments available to non-GP providers are for notification to the ACIR (i.e., information payments), which have remained at approximately A\$8 million annually since the ACIR's introduction. Payments specific to GPs are substantially larger and have risen since their inception from A\$26 million to A\$40 million annually, due to increasing numbers of GP providers rather than any increase in unit payment. By 2004, the amount paid to general practices for achieving certain targets for immunisation coverage at the practice level was approximately equal to that paid through SIP for vaccines delivered, despite increasing the coverage required for being eligible for payment from 85% to 90% in 2003. In the 2008 federal budget, it was announced that the SIP component of the GPII Scheme would be discontinued from October 2008 [38]. It remains to be seen whether this change will impact immunisation coverage, however as other incentives remain intact, it is hoped that there will be minimal impact.

Total payments to GPs are much lower than parental payments, because of the latter's greater numbers. In 2004–05, following removal of the means test to qualify, payment of the MIA was A\$43 million. It is likely that this payment, A\$233 per child in 2007, is substantial enough to provide motivation both to complete immunisation and for parents to prompt their provider to notify outstanding reports to the ACIR before the child reaches 24 months of age. ACIR-reported coverage at 12 and 24 months of age reached 90% by 2000, approximately 18 months after the introduction of the GPII Scheme. However, the increase in the level of complete immunisation at 24 months of age was considerably steeper than for 12 months of age, suggesting that the parental incentive payment had a substantial independent influence. A study in 2000 was able to demonstrate a significant association between receipt of both the MIA and the CCB and completion of immunisation [39]. Since that time, removal of means testing of the MIA may also have increased impact. In the 2008 budget, it was announced that the MIA payment would be paid in two equal amounts of A\$167, with eligibility for the second payment assessed at 4–5 years of age [38]. It remains to be seen whether this will impact 72-month coverage.

In summary, the ACIR has been instrumental in extending and evaluating the reach and impact of Australia's publicly funded childhood immunisation programs. Coverage targets have been reached

for two of the milestone ages and are close to being realised for the third. Many other countries have universal national health insurance schemes and linkage to these, based on the ACIR experience, appears likely to be an appropriate model in various settings, providing legislative and privacy issues can be addressed.

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