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Tailoring childhood immunisation services in a socioeconomically disadvantaged community in New South Wales, Australia: a cost analysis

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ABSTRACT

Background. Using the World Health Organization's 'Guide to Tailoring Immunization Programmes' (TIP), a three-step program was developed by health services in partnership with a marginalised community in New South Wales, Australia. The aim was to improve immunisation rates of 1-year-old children. For Step 1, nurses identified and monitored local children overdue for immunisation from a national register, and sent parents or family doctors reminders by mail or telephone. For Step 2, parents were offered appointments at a local health centre; and for Step 3, they were offered home visits. **Methods.** An economic costing study was undertaken to examine the program's resource use. Costs were collected between 1 June 2020 and 31 May 2021. Case records were obtained for 139 children. **Results.** A total of 56 children became up to date after receiving TIP services; most after receiving Step 1 services ($n = 37$). Total annual costs (A$) for the program were $34 250 or $246 per case; or $612 per case becoming up to date. At $44 per case and $98 per case becoming up to date, Step 1B: personalised reminders, was the lowest costing step. Sensitivity analysis showed a possible 8% program savings through employment of nurses with a lower salary and use of video conference meetings. **Conclusion.** This study provides information to the local health provider on the cost of TIP alongside their community-based programs. It also identified ways in which TIP could be made more cost-effective. Decision-makers can use this information to consider whether the investment in TIP is recommended.

Keywords: community health: services, equity, health care: costs, immunisation programs, primary health care.

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Introduction

Immunisation protects children against potentially deadly or debilitating diseases, including measles, diphtheria, pertussis and polio, and strengthens community resilience through herd immunity (Brisson and Edmunds 2003). In the USA, the Centers for Disease Control and Prevention estimates that for each $1 spent on childhood immunisations, there are approximately $5 of savings in future direct medical costs and avoided productivity losses (Philipson *et al.* 2017). Reports from the Australian Immunisation Register (AIR) indicate that Australia is close to achieving its aspirational target of 95% immunisation coverage for 1–5-year-old children (Australian Government Department of Health 2020*a*). As of September 2021, 94.8% of all 1 year olds, 92.6% of all 2 year olds and 95.1% of all 5 year olds were fully immunised (Australian Government Department of Health 2020*a*). Despite these high rates, pockets of lower immunisation coverage persist. Australia's National Immunisation Strategy (2019–2024) prioritises actions to improve immunisation rates in areas where coverage is low and to facilitate equitable access to immunisation for all Australians, regardless of financial or geographic barriers (Australian Government Department of Health 2018).

Reaching pockets of under-immunised children require tailored strategies that address the unique barriers experienced by communities. The World Health Organization

developed the Tailoring Immunization Programmes guide (TIP) to assist public health services identify areas of low coverage, to gain an understanding of barriers to immunisation uptake, and to develop effective tailored strategies for improving coverage rates. Since 2017, TIP has been gradually rolled out in Maitland, NSW, a regional city of almost 80 000 people located 170 km north of Sydney, with relative socioeconomic disadvantage (Australian Bureau of Statistics 2018).

Implementation of the TIP program in Maitland, NSW

The program focused on children in the Australian Bureau of Statistics Statistical Area Level 2 (Australian Bureau of Statistics 2016) zones of Maitland East and Maitland West. AIR data uncovered relatively high numbers and rates of children at least 30 days overdue for at least one scheduled immunisation (15.4%) in 2016. One-year-old children accounted for 37.8% of these cases (Thomas *et al*. 2018).

Applying the TIP approach, Public Health Unit (PHU) staff from Hunter New England Local Health District (HNELHD) identified factors driving low immunisation rates in this area: socioeconomic hardship and access barriers to health services (Thomas *et al*. 2022). A tailored 'Three Step Process' for 1-year-old children was developed and implemented by PHU staff and Child and Family Health Nurses (CFHNs; Thomas *et al*. 2018).

PHU immunisation nurses monitor the AIR data for children in target suburbs who appear as overdue for routine immunisations, entering them into the program. In Step 1, the child's AIR record is reviewed, with details updated where applicable. For those children with a regular GP, PHU nurses contact the practice to recommend the child be recalled for overdue immunisations and/or to update the AIR. Parents of children without a regular GP are sent personalised reminder letters, advising them to seek immunisation through a local GP or the council clinic. If Step 1 does not result in the child becoming up to date, children progress to Step 2, where they are offered an outreach clinic appointment. If the child remains overdue, they progress to Step 3, where they are offered home visits. Steps 2 and 3 are provided by CFHNs. In some instances, nurses made discretionary decisions on when to progress children between the steps, based on individual circumstances (i.e. lack of transport, large number of other children, poor mental health of the mother, substance misuse). TIP services are above and beyond usual care, which would usually involve generating lists of children who appear as overdue on AIR across HNELHD and sending standard government reminders. In Maitland, immunisations were available through general practice and a local council clinic. The CFHN service did not offer immunisations, but rather, checked children's records, and provided advice and information.

Decisions on the continuation and/or expansion of the TIP program required information on the resources the program consumes. Such information allows decision-makers to assess whether the use of resources in each TIP step is favourable, given resources are limited. The health service providing TIP has not previously had information available to allow a comparison of costs against outcomes.

To assist pragmatic decision-making in an operational health service, the aim of this study was to analyse the economic costs of the TIP program, where 'economic costs' are the opportunity costs of the resources expended in the running of TIP, which could be used in the production of alternative health services. Results are of interest to decision-makers when considering program value and efficiency, and for informing potential scale-up.

To the authors' best knowledge, this is the first economic study of a stepped immunisation program for 1-year-old children in Australia.

Methods

Costing study time horizon and perspective

This study was undertaken from the cost perspective of the TIP provider, public health funding agency, HNELHD. The time horizon for the study was 1 year: 1 June 2020 to 31 May 2021.

As TIP was conducted within standard immunisation services, TIP costs were wholly incremental, representing the difference between running and not running TIP.

Resource use identification, measurement and valuation

The study represents a 12-month cross-section of activity generated by TIP. It was aligned to the implementation of TIP in the Maitland area, permitting the prospective identification and measurement of the resources associated with the program.

Two datasets were created during the study period:

1. A custom-built database identifying and measuring the economic costs associated with TIP
2. A custom-built database of TIP cases for the study period, flagging their receipt of TIP services for any of the steps

The TIP cases dataset was constructed from historical records and included immunisation outcomes for 6 months beyond the study period (to 30 November 2021) to allow for a lagged effect from service provision (Fig. 1).

For (1), a 'bottom-up' costing method was employed to estimate the resources to deliver TIP. Program costs were collected for each month's activity separately for cases in Step 1, Step 2 and Step 3 (Supplementary material S1).

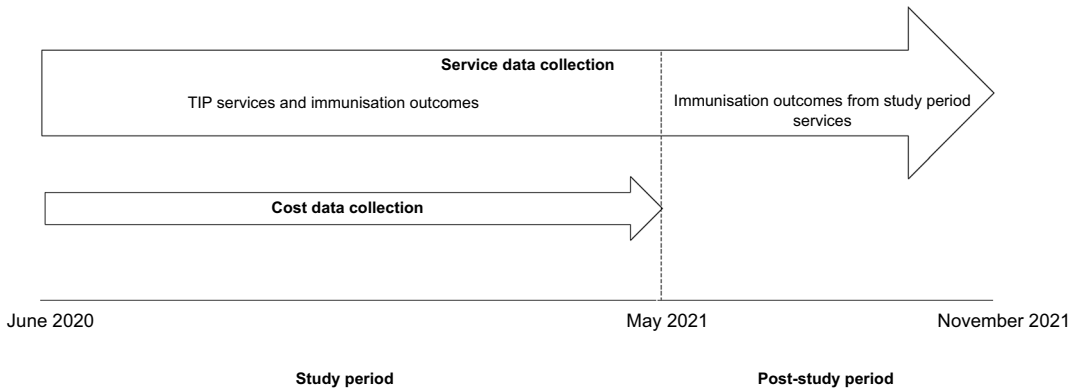

Fig. 1. Study period and data collection.

Costs were also collected for TIP 'Clinical Coordination' – management and administration. A subcategory of Step 1 costs was created for activity occurring when children flagged on AIR as overdue were found to be 'up to date' (Step 1A: AIR Review/Corrections). These activities involved PHU nurses reviewing AIR records, contacting parents and/or general practices, and, if applicable, updating or correcting the AIR. Children who were up to date then exited the program. Costs for this program segment were attributed to the cases that were exited. Children could exit the program at any time for other reasons, including parent's declining immunisation or if the family moved outside the area. Step 1 costs related to reminders for children confirmed as overdue were placed in subcategory, 'Step 1B: Personalised Reminders'.

Costed resources included: the amount of time spent implementing the intervention, travelling costs for meetings, materials used, personalised reminder letters and injection consumables. Staff involved with implementing TIP included: PHU Immunisation Clinical Nurse Consultant (CNC) and an Aboriginal Immunisation Health Worker, two CFHNs valued at the grade of clinical nurse specialists (CNS) and a PHU Data Analyst who extracted the AIR data used by the nurses for program monitoring.

A further cost was purchase of a dedicated vaccine refrigerator to safely store vaccines at the outreach clinic, amortised over 3 years. All resources were valued in 2021 Australian dollars (Australian Bureau of Statistics 2021). Vaccine costs for Steps 2 and 3 were omitted, as they are provided free of charge by the Commonwealth Government (Australian Government Department of Health 2020*b*) and are not a cost to HNELHD.

References for resource valuation included wage awards (Industrial Relations Commission of New South Wales 2021*a*, 2021*b*, 2021*c*); catalogues for medical materials, and service receipts for stationery and capital costs (vaccine fridge). Travel costs for meetings were based on the Australian Tax Office's car travel expenses allowance of 72 cents per kilometre (Australian Tax Office 2022); phone calls were costed from the Telstra Business Plan (Telstra 2020). 'On-costs' (including holiday pay, superannuation) were estimated from a local published source (University of Western Sydney 2021) and added to labour costs. Overhead costs (including electricity, security) were included based on labour costs at a rate of 27.5% (Greater Metropolitan Health Services 2016). A full list of unit costs and parameters and their sources appears in Table 1.

The custom-built database of TIP cases included all children who received a TIP step service during the study period, including those whose AIR records required updates. The database included children that had commenced TIP prior to the study period and received Step 2 or 3 services between 30 June 2020 and 31 May 2021. For cases still in TIP at the end of the study period, AIR data were collected to the time of writing (30 November 2021) to observe later positive outcomes.

Ethics approval

Ethics approval for the study obtained from the Hunter New England Human Research Ethics Committee (2018/ETH00185: ID016220).

Results

TIP services were provided for 139 cases; 130 entered during the study period, and nine commenced before 1 June 2020. Of the 130 cases that entered Step 1, 47 (36.2%) were excluded, being found to be up to date or declining immunisation. The other 83 received Step 1B: Personalised Reminders. Of these, 37 (44.9%) became up to date in Step 1 (26 in study period, 11 in post study period). Twenty-two cases progressed to Step 2 in the study period. Four others, that had entered Step 1 before 1 June 2020, also entered Step 2 in the study period. Among these 26 cases, 14 became up to date in Step 2 (12 in the study period; two in the post study period). Five cases entered Step 3 during the study period, all of which were already in Step 2 before the study period. At the end

Table 1. Unit costs and parameters.

Labour		Reference	Date accessed
Implementation team	Hourly rate (A$)		
CNC Grade 3, 2nd year	$65.32	https://www.health.nsw.gov.au/careers/conditions/awards/nurses.pdf	24 February 2022
Senior Analyst, 6th year	$59.50	https://www.health.nsw.gov.au/careers/conditions/Awards/hsu-he-computer-staff.pdf	24 February 2022
CNS Grade 2, 2nd year	$53.71	https://www.health.nsw.gov.au/careers/conditions/awards/nurses.pdf	24 February 2022
Aboriginal Health Worker, 9th year	$41.36	https://www.startts.org.au/media/NSW-Health-Salary-Levels_July-2021.pdf	24 February 2022
Administrative Officer Level 2, 2nd year	$53.71	https://www.health.nsw.gov.au/careers/conditions/Awards/hsu-he-administrative.pdf	24 February 2022
Administration Officer Level 1, 5th Year	$29.13	https://www.health.nsw.gov.au/careers/conditions/Awards/hsu-he-administrative.pdf	24 February 2022
Reminder letter	Cost per letter		
Envelopes	$0.25	Research records	
Coloured paper sheets	$0.02	Research records	
Stamps	$1.10	Research records	
Invitation cards	$1.00	Research records	
Total	$2.37		
Injections[A]	Cost per injection		
Gloves	$0.15	NSW Health State-wide Catalogue	6 February 2020
Needle 18-G, drawing up	$0.18	NSW Health State-wide Catalogue	7 February 2020
Needle 23-G, injection	$0.18	NSW Health State-wide Catalogue	8 February 2020
Syringe	$0.23	NSW Health State-wide Catalogue	9 February 2020
Alcohol swab	$0.01	NSW Health State-wide Catalogue	10 February 2020
Cotton ball, sterile	$0.10	NSW Health State-wide Catalogue	11 February 2020
Spot dressing (band aid)	$0.01	NSW Health State-wide Catalogue	12 February 2020
Total	$0.86		
Other costs			
Sharps container	$7.84	Market value, research records	
Vaccine fridge	$2387	Market value, research records	
Annual phone plan for pop health	$83	https://www.telstra.com.au/content/dam/tcom/personal/consumer-advice/pdf/business-a-full/bg-fixed-bps.pdf	30 August 2021
Travel cost per kilometre	$0.72	https://www.ato.gov.au/individuals/income-and-deductions/deductions-you-can-claim/vehicle-and-travel-expenses/car-expenses/	24 February 2022
Parameters			
Overhead rate	27.50%	Finance department, Hunter New England Health (pers. comm.)	
Labour on-costs rate	20%	https://www.westernsydney.edu.au/human_resources/ohr/on_costs	9 September 2021

[A]Vaccines not included as a Commonwealth cost.

of the study period, all other cases remained in Steps 1 or 2, or had left the program (Fig. 2). In total, 56 cases (43 in study period, 13 in the post study period) had become up to date after receiving TIP services.

Table 2 shows the total economic cost for the program over the study period as $34 250 or $246 per case, and $612 per case becoming up to date. Respective total costs for Clinical Co-ordination, Step 1 A, Step 1B, Steps 2 and 3 were: $17 650, $5065, $3643, $4881 and $3011. Labour was the largest cost component, and was highest for Clinical Coordination and Step 1 A. Step 3 had the highest per case costs, given the greater per case resources with a home visit from two nurses (as per health policy).

Table 3 contains results of one-way sensitivity analyses. The first shows that if the labour of the immunisation CNC can be performed by a lower cost CNS, the total cost

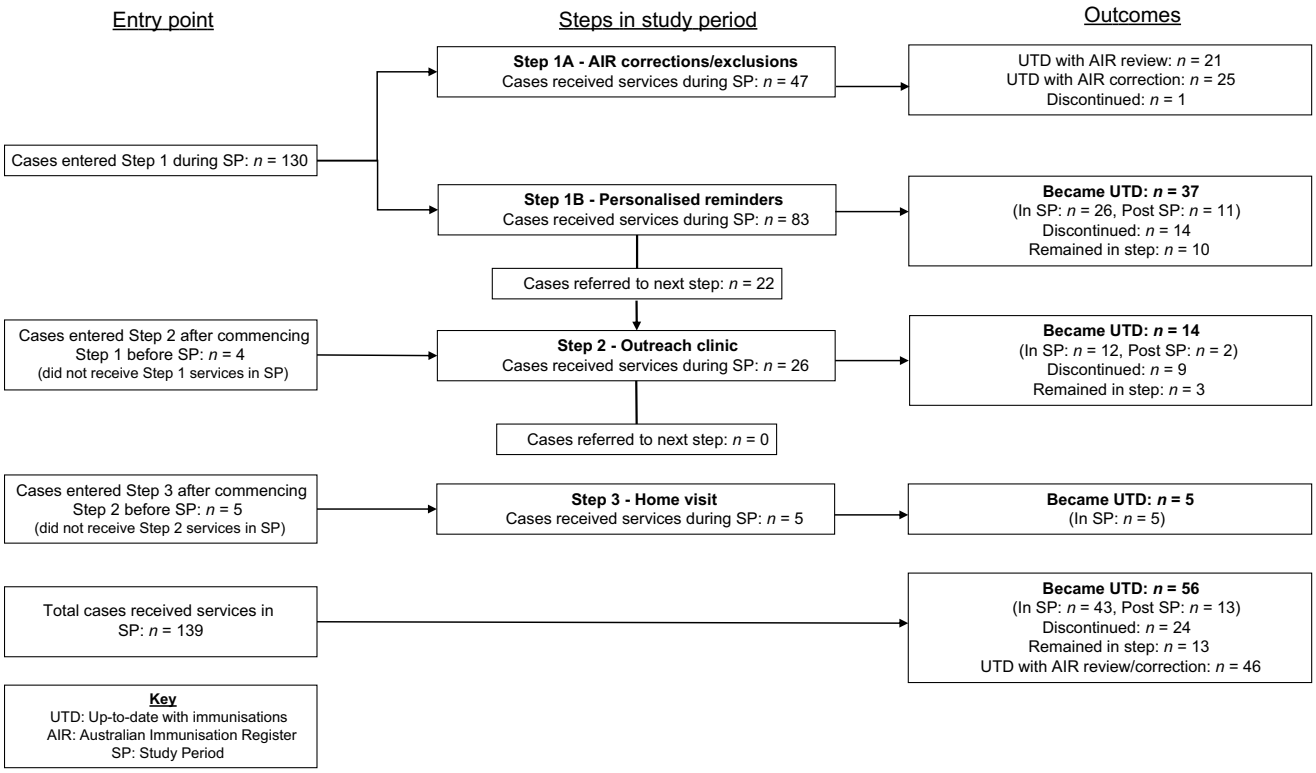

Fig. 2. TIP cases (*n*) by step activity (1 June 2020 to 31 May 2021).

Table 2. TIP economic costs (A$) and outcomes (1 June 2020 to 31 May 2021).

	Clinical coordination	Step 1A: AIR Corrections/exclusions	Step 1B: Reminders	Step 2: Outreach	Step 3: Home visit	Total
Program cost						
Labour	$15 961	$4121	$2802	$3836	$2256	$28 975
Overhead	$1491	$944	$642	$879	$517	$4473
Travel	$198		$0	$0	$99	$296
Reminder letter			$149			$149
Injections				$22	$12	$34
Vaccine fridge (depreciated)					$119	$239
Telephone business plan			$50	$25	$8	$83
Total program cost	$17 650	$5065	$3643	$4881	$3011	$34 250
Program outcomes						
Active in step in study period	139	47	83	26	5	139
Found UTD at entry			46			
Classified as declined at entry			1			
Became UTD	56		37	14	5	56
Cost per						
Case	$127	$108	$44	$188	$602	$246
Case became UTD	$315	NA	$98	$349	$602	$612

UTD, up to date with scheduled immunisations.

and cost per case becoming up to date would be reduced by 4.7%. The savings effect would be much larger for Step 1A: AIR Corrections/Exclusions (12.7%) and Step 1B: Personalised Reminders (9.8%). Holding monthly meetings

Table 3. TIP economic costs (A$): sensitivity scenarios (1 June 2020–31 May 2021: 139 cases).

	Clinical coordination		Step 1A: AIR Corrections/ exclusions		Step 1B: Reminders		Step 2: Outreach		Step 3: Home visit		Total	
	(Total $)	(% Δ)	($)	(% Δ)	($)	(% Δ)	($)	(% Δ)	($)	(% Δ)	($)	(% Δ)
Base case	$17 650		$5065		$3643		$4881		$3011		$34 250	
Cost per:												
Case	$127		$108		$44		$188		$602		$246	
Case became UTD	$315		NA		$98		$349		$602		$612	
1 CNC replaced by CNS	$17 034	−3.5%	$4420	−12.7%	$3286	−9.8%	$4881	0.0%	$3011	0.0%	$32 632	−4.7%
Cost per:												
Case	$123	−3.5%	$94	−12.7%	$40	−9.8%	$188	0.0%	$602	0.0%	$235	−4.7%
Case became UTD	$304	−3.5%	NA		$89	−9.8%	$349	0.0%	$602	0.0%	$583	−4.7%
2 Monthly Meetings: ZOOM	$16 484	−6.6%	$5065	0.0%	$3643	0.0%	$4881	0.0%	$3011	0.0%	$33 083	−3.4%
Cost per:												
Case	$119	−6.6%	$108	0.0%	$44	0.0%	$188	0.0%	$602	0.0%	$238	−3.4%
Case became UTD	$294	−6.6%	NA		$98	0.0%	$349	0.0%	$602	0.0%	$591	−3.4%
3 (1 and 2)	$15 919	−9.8%	$4420	−12.7%	$3286	−9.8%	$4881	0.0%	$3011	0.0%	$31 517	−8.0%
Cost per:												
Case	$115	−9.8%	$94	−12.7%	$40	−9.8%	$188	0.0%	$602	0.0%	$227	−8.0%
Case became UTD	$284	−9.8%	NA		$89	−9.8%	$349	0.0%	$602	0.0%	$563	−8.0%

by videoconference, thus eliminating travel costs, could reduce Clinical-Coordination resource use by 6.6% or overall, by 3.4%. This later change has already been implemented.

Discussion

This study reports the cost to an operational health service of implementing a tailored strategy to improve childhood immunisation rates in a geographic area of low coverage. It provides decision-makers with information on the resources required to deliver each aspect of TIP-information that was not previously available.

The highest proportion of costs were for labour, particularly in the Clinical Coordination and Step 1A: AIR Corrections/Exclusions. Most cases that became up to date reached this status immediately after Step 1B: Personalised Reminders.

The three step process has re-oriented existing services rather than building a new team with additional staff and vehicles. PHU and CFHN nurses refocused resources on a target group of disadvantaged children using personalised reminders, outreach and home visiting. In their systematic review, Ozawa *et al.* (2018) found reminders to be the most common interventions used to improve coverage rates in high-income countries. The authors found that strengthening health service delivery was the least costly of intervention strategies, suggesting changes to policy and practice at a system level can be effective in improving rates (Ozawa *et al.* 2018).

Interventions that immunise large numbers of children, as in community-based programs, are likely to be more efficient than those targeting small groups. However, if the aim is to maximise immunisation rates across a given age cohort, it may be necessary to deliver tailored interventions to improve equity of access for those families that require more flexible services that meet their individual needs and circumstances. In this case, tailored programs, such as TIP, are likely to be less efficient than community-based programs; however, their ability to lift immunisation rates in pockets of low coverage where structural and access barriers exist can help achieve national targets and strengthen community resilience. This is also important, because high coverage rates and herd immunity in one area will not necessarily provide herd immunity in nearby areas of low coverage, particularly if there is little mixing of the groups (Tuckerman *et al.* 2008).

TIP requires an incremental cost for health services. Rather than replace usual care, it is in addition to it. Although each step has a progressively higher ‘per case’ and ‘per case becoming up to date’ cost, the ‘gateway’ approach means that fewer cases require the intensity of Step 2 and Step 3. There are possibilities for reducing the cost of TIP with the substitution of CNS for CNC nurses and by using video-conferencing instead of travelling to face-to-face staff meetings. A TIP program could operate with greater efficiency if the CFHN service prioritised immunisation for all children as core business; and GPs and federal government agencies ensured the accuracy and timeliness of AIR data.

It is possible that other factors influenced childhood immunisation rates in the target group; for example, the 'No Jab No Pay' legislation. However, previous analysis of AIR data found little improvement in immunisation rates in our target group after 1 year of its implementation. This may be because parents were not opposed to immunisation, but rather, experienced significant social and structural barriers to accessing health services (Thomas *et al.* 2017).

The average time for children to progress from 'overdue' to 'fully up to date' was approximately 9 months. Although this lag may seem long, the average number of injections initially overdue among children serviced by TIP was 4.3 (range 1–9). An appropriate catch-up schedule can require several appointments over 6–12 months (Australian Government Department of Health 2022). Many families in the program were found to have conflicting priorities that required rescheduling of immunisation appointments, which also had an impact on the time required to bring their children up to date (Thomas *et al.* 2022).

Limitations

As a pragmatic economic study of a real-world public health program, this study had limitations. Clear paths of causation between the TIP intervention and becoming up to date were not identified. Except for children in Steps 2 and 3, the study had no patient data confirming the influence of TIP on families' decisions to seek immunisations. Future studies of services, such as TIP, should collect this information. Full immunisation rates for the TIP target group have increased in East and West Maitland from 62.3% in 2016 (just before the implementation of TIP) to 86.2% in 2020 (Thomas *et al.* 2022), but this alone is not evidence of the effectiveness of TIP.

This study measured the costs of implementing TIP that are additional to usual care. It was not designed to compare the cost or outcomes of TIP with alternative services that also target groups who do not respond to community-based immunisation programs.

The study did not measure downstream cost savings arising from increasing the rate of fully immunised children, nor did it measure potential secondary benefits from TIP, including improved access to primary health care with early detection of health problems, timely referrals to appropriate services and associated improvement in quality of life.

Conclusion

The strength of any causal relationship between TIP and rates of full immunisation cannot be estimated with certainty; however, coverage of the 1-year-old age group is increasing across East and West Maitland (Thomas *et al.* 2022). It is feasible that the implementation of TIP has contributed to improved equity of access to childhood immunisation by offering more flexible options to families who may be struggling with social and structural barriers. This study has provided information to the health service on the cost of implementing a tailored program for a target group, helping to ensure that scarce resources are allocated to service those most in need. It has also identified ways in which TIP could be made more cost-effective. Decision-makers can use this information to consider whether the investment in TIP is favourable.

Supplementary material

Supplementary material is available online.

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