

What do maternity services produce? An exploration of potential output measures to assess the efficiency and productivity of maternity services in Australia.

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Research Article

Keywords: Maternity, efficiency and productivity, maternity outcome measures

Posted Date: December 1st, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-114705/v1>

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Abstract

Background: In maternity services, as in other areas of healthcare, increasing emphasis is placed on improving “efficiency” or “productivity”. The first step in any efficiency and productivity analysis is the selection of relevant input and output measures. Within healthcare quantifying what is produced (outputs) can be difficult.

The aim of this paper is to identify potential output measures that reflect the principles of woman-centred care and that can be used in an assessment of the efficiency and productivity of maternity services in Australia.

Methods: This paper will survey available perinatal and maternal datasets in Australia to identify potential output measures; map identified output variables against the principles of woman-centred care outlined in Australia’s national maternity strategy; and based on this data, create a preliminary composite outcome measure for use in assessing the efficiency and productivity of Australian maternity services.

Results: The identified composite measure consists of labour and birth outcomes indicators where data is available from the National Perinatal Data Collection. The composite measure makes it very clear that there are significant gaps in Australia’s maternity data collections with regard to measuring how well a maternity service is performing against the values of respect, choice and access.

Conclusions: Adoption in Australia of the collection of woman-reported maternity outcomes would substantially strengthen Australia’s national maternity data collections and provide a more holistic view of pregnancy and childbirth in Australia beyond traditional measure of maternal and neonate morbidity and mortality.

Background

In maternity services, as in other areas of healthcare, increasing emphasis is placed on improving “efficiency” or “productivity” (1, 2). These terms are sometimes seen as synonymous with cost-cutting, and those on the frontline of delivering care may feel that the terms are used as a means of facilitating the reduction of resources with little concern for how that affects the quality of care (3, 4). Such scenarios are actually not congruent with what efficiency and productivity relate to. Efficiency and productivity measurement allows comparison of the relative performance of a given set of entities (for example hospitals) that produce the same or similar goods and/or services (for example, maternity care).

Formally, productivity is defined as the ratio of outputs to inputs and can be represented by a production frontier, with input(s) on the (x) axis and output(s) on the (y) axis. The production frontier represents the maximum output that could be produced from each input level given current technology. Firms operate either on that frontier, if they are technically efficient or beneath the frontier if they are not technically efficient. If a firm is beneath the frontier, this indicates that they could be producing more outputs than they currently are. Technical efficiency is defined as the production of the maximum amount of output from a given amount of input (or alternatively the production of a given output with minimum input quantities) given current technology. Allocative efficiency is similar to technical efficiency but places a cost on inputs or outputs. Allocative efficiency is defined as the input mix that minimizes cost, given input prices or when the output mix maximizes revenue, given output prices. Together, technical and allocative efficiency comprise overall economic efficiency (5). Efficiency and productivity measurement places equal emphasis on inputs (or costs) and outputs (what is actually produced). If costs are reduced and what is produced also simultaneously declines, productivity is not increased, and efficiency is unlikely to be reached.

In any efficiency and productivity analysis the selection of relevant input and output measures is an essential first step. However, within healthcare capturing what is produced can be difficult. Output measures should reflect the function and key activities of a given industry and allow comparison of both the quantity and quality of output (5). For the health industry, the most relevant output variable would be one that measures the health gains of individual patients who seek treatment (6, 7). However, there is often limited data available on individual patient outcomes. Many efficiency and productivity studies therefore utilise proxy measures of health outcomes, such as number of patients treated or length of stay.

The limitations of proxy measures of health outcomes, such as number of patients or length of stay, is further pronounced when considering the performance of maternity services and the importance of woman-centred care. Woman-centred care promotes the principles of choice, control, continuity of caregiver and self-determination (8, 9). It is increasingly being incorporated in Australia and other jurisdictions as the foundation of the provision of safe and effective maternity care (10, 11) Woman-centred care recognizes that a ‘successful’ birthing experience is defined by more than the delivery of a healthy baby and the physical safety of the mother. The selection of output measures to assess the efficiency and productivity of maternity services should therefore also move beyond simple measures of maternal and neonate morbidity and mortality and indicators of clinical activity, and towards those variables that capture the entirety of the birthing experience.

The aim of this paper is to identify potential output measures that reflect the principles of woman-centred care and that can be included in an assessment of the efficiency and productivity of maternity services in Australia. This paper will survey available perinatal and maternal datasets in Australia to identify potential output measures; map identified output variables against the principles of woman-centred care outlined in Australia’s national maternity strategy *Woman-centred care: Strategic Directions for Australian Maternity Services*; and based on this data, create a preliminary composite outcome measure for use in assessing the efficiency and productivity of Australian maternity services.

Methods

Principles of maternity care in Australia

The Australian national strategy, *Woman-centred care: Strategic Directions for Australian Maternity Services*, outlines a means to support the delivery of maternity services for women from conception until 12 months after pregnancy or birth. The Strategy outlines four values – safety, respect, choice and access – which underpin twelve principles for woman-centred maternity care that apply to all health professionals providing maternity services (12). An additional file outlines these twelve principles (see Additional file 1).

This national strategy provides a useful framework for considering potential output variables for assessment of the efficiency and productivity of maternity services in Australia. Ideally, any efficiency and productivity analysis would incorporate output variables that correlate with and indicate how well a maternity service is delivering care in accordance with these twelve principles (12).

Data scoping

A search was conducted for datasets available within Australia that related to maternal health care. A Google search engine (Chrome) was used to search for and identify relevant datasets. The following keywords and phrases were included in the search: *Maternal; Maternity; Perinatal; Pregnancy; Childbirth; Data; Collection; Indicators*

Data mapping

Identified datasets relating to maternal health care were reviewed. The contents of each dataset was mapped to the four values of safety, respect, choice and access outlined in Australia's national maternity strategy. From this mapping exercise a preliminary composite outcome measure was constructed for use in assessing the efficiency and productivity of Australian maternity services.

Results

Existing maternity and perinatal data sets in Australia

National Perinatal Data Collection and National Core Maternity Indicators

The National Core Maternity Indicators (NCMIs) provide information on measures of clinical activity and outcomes in relation to maternity care across Australia. The purpose of the indicators is to establish baseline data to monitor and evaluate maternity care in Australia and enable continuous improvement in care. The NCMIs are clinical indicators of maternity care, where a clinical indicator is defined as a measure of the clinical management and outcome of care and is based on evidence that confirms the underlying causal relationship between a particular process or intervention and health outcome (13). The NCMIs are constructed from data items from the Australian Institute of Health and Welfare (AIHW) National Perinatal Data Collection (NPDC), a national population-based collection that provides information on the pregnancy and childbirth of mothers, and the characteristics and outcomes of their babies. The NPDC captures all births in Australia in hospitals, birth centres and the community (14).

Tables 1 and 2 map the NCMIs and NPDC data item against the four values of the national strategy – safety, respect, choice and access.

Table 1: National Core Maternity Indicators mapped to the values' of the Australian national maternity strategy

Indicators	Safety	Respect	Choice	Access	Cost Adjustment
Antenatal Period Indicators					
Tobacco smoking in pregnancy: a. in the first 20 weeks of pregnancy for all women giving birth b. after the first 20 weeks of pregnancy for all women who gave birth and reported smoking during pregnancy					X
Antenatal care in the first trimester for all women giving birth					X
Labour and Birth Indicators					
Induction of labour for selected women* giving birth for the first time	X		X		
Caesarean section for selected women giving birth for the first time	X		X		
Non-instrumental vaginal birth for selected women* giving birth for the first time	X		X		
Instrumental vaginal birth for selected women* giving birth for the first time	X		X		
Episiotomy for women having their first baby and giving birth vaginally: a. without instruments to assist the birth b. assisted with instruments	X		X		
General anaesthetic for women giving birth by caesarean section	X				
Women having their second birth vaginally whose first birth was by caesarean section	X		X		
Birth Outcome Indicators					
Apgar score of less than 7 at 5 minutes for births at or after term	X				
Small babies among births at or after 40 weeks gestation	X				
Third and fourth degree tears: a. for all vaginal first births b. for all vaginal births	X				

*Rather than the whole population, these indicators are measured only for 'selected women'. This is women whose characteristics indicate they have a lower risk of birth complications and therefore provide a better indication of what are expected outcomes in 'standard' cases. Selected women are aged between 20-34 years; gave birth between 37-41 completed weeks of gestation; had a singleton baby who presented in the vertex (head down) position (17)

Table 2: National Perinatal Data Collection Minimum Data Set mapped to Australian national maternity strategy values

Data Item	Safety	Respect	Choice	Access	Cost Adjustment
Birth event—anaesthesia administered, yes/no	X				
Birth event—analgesia administered, yes/no			X		
Birth event—birth method: Vaginal—non-instrumental; Vaginal—forceps; Caesarean section; Vaginal— vacuum extraction	X				
Birth event—birth plurality: Singleton; Twins; Triplets; Quadruplets; Quintuplets; Sextuplets; Other					X
Birth event—birth presentation: Vertex; Breech; Face; Brow; Other	X				
Birth event—labour onset type: Spontaneous; Induced; No labour	X		X		
Birth event—setting of birth (actual): Hospital, excluding birth centre; Birth centre, attached to hospital; Birth centre, free standing; Home; Other			X	X	
Birth event—state/territory of birth					X
Birth event—type of anaesthesia administered: Local anaesthetic to perineum; Pudendal block; Epidural or caudal block; Spinal block; General anaesthesia; Combined spinal-epidural block; Other anaesthesia	X		X		
Birth event—type of analgesia administered: Nitrous oxide; Epidural or caudal block; Spinal block; Systemic opioids; Combined spinal-epidural block; Other analgesia	X		X		
Birth—Apgar score (at 5 minutes)	X				
Birth—birth order: Singleton or first of a multiple birth; Second of a multiple birth; Third of a multiple birth; Fourth of a multiple birth; Fifth of a multiple birth; Sixth of a multiple birth; Other	X				
Birth—birth status: Live birth; Stillbirth (fetal death)	X				
Birth—birth weight, total grams	X				
Episode of admitted patient care—separation date					X
Establishment—organisation identifier (Australian)					X
Female (mother)—postpartum perineal status: Intact; 1st degree laceration/vaginal graze; 2nd degree laceration; 3rd degree laceration; Episiotomy; 4th degree laceration; Other perineal laceration, rupture or tear	X				
Female (pregnant)—number of cigarettes smoked (per day after 20 weeks of pregnancy)					X
Female (pregnant)—tobacco smoking indicator (after twenty weeks of pregnancy), yes/no					X
Female (pregnant)—tobacco smoking indicator (first twenty weeks of pregnancy), yes/no					X
Female—caesarean section at most recent previous birth indicator, yes/no	X				
Female—number of antenatal care visits					X
Female—parity, total pregnancies	X				
Person—area of usual residence, statistical area level 2 (SA2) code (ASGS 2016)					X
Person—country of birth					X
Person—date of birth					X
Person—Indigenous status: Aboriginal but not Torres Strait Islander origin; Torres Strait Islander but not Aboriginal origin; Both Aboriginal and Torres Strait Islander origin; Neither Aboriginal nor Torres Strait Islander origin					X
Person—person identifier					X
Person—sex: Male; Female; Intersex or indeterminate					X
Pregnancy—estimated duration (at the first visit for antenatal care), completed weeks	X				
Product of conception—gestational age, completed weeks	X				

It can be seen that the NCMI and NPDC data items relate predominantly to issues of safety and largely neglect those of respect, choice and access. Nevertheless, many of the NCMI have some utility when considering the efficiency and productivity of maternity services.

Labour and Birth Indicators capture a number of common interventions in delivery. Although interventions in delivery are often required to ensure the safety of mother and baby, Australia is known to have a high rate of potentially unnecessary Caesarean sections, induction and episiotomy (15, 16). This can be seen as symptomatic of the medicalisation of the birthing experience and in the context of woman-centred care there is a clear impetus to eliminate unnecessary birth interventions. These labour and birth indicators are therefore highly relevant to include as output variables in efficiency and productivity measurement, as they can provide some indication as to how well a maternity service is providing care that adheres to the national strategy values of safety, respect, choice and access. Maternity services with a similar casemix should exhibit a similar rate of birth intervention. Differences in intervention rates could therefore indicate a high rate of unnecessary birth intervention in a given service and a deviation from the values and principles of the national strategy.

Birth Outcome Indicators capture important information regarding the physical health of mother and baby following labour and delivery. A baby's Apgar score assesses the clinical status of a baby immediately following childbirth. Third and fourth degree tears are classified as severe trauma to the perineum and can occur spontaneously or as a result of obstetric intervention during vaginal birth. Birthweight is a key indicator of a baby's health and is used as a measure of health and wellbeing of the mother in pregnancy, as well as an indication of a baby's chance of survival, health, development and wellbeing (17). The physical health of mother and baby is obviously central to the provision of safe and effective maternity care and these indicators are therefore logical choices for inclusion as output variables in an efficiency and productivity analysis.

The NCMI Antenatal Period Indicators capture maternal behaviours that have been shown to be associated with child health outcomes (13). Smoking during pregnancy is a risk factor for many adverse outcomes in pregnancy, including pre-term birth, placental complications and perinatal death of the baby. Antenatal care in the first trimester is associated with better maternal health in pregnancy, fewer interventions in late pregnancy and positive child health outcomes (13).

Indicators such as these are more appropriately included in an efficiency and productivity analysis as measures of input, rather than output measures. This is because they influence the complexity of care a woman may receive and therefore the resources consumed in delivering this care. E.g. women who smoke or do not receive antenatal care are at higher risk of a number of adverse outcomes in pregnancy, requiring higher complexity and more resource intensive maternity care. Indicators like these relating to maternal behaviours or characteristics are also a reflection of the casemix of any given maternity service. In an efficiency and productivity analysis, input measures can be 'cost adjusted' to account for the casemix of a given hospital, which can help distinguish between those maternity services who consume more inputs because they treat more complex patients and those who consume more inputs as a result of technical or allocative inefficiencies. Tables 1 and 2 indicate NCMI and NPDC items that are more appropriately included in an efficiency and productivity analysis as a cost adjustment measure.

The NCMI and NPDC collect a number of data items that can usefully be incorporated as output variables in an assessment of the efficiency and productivity of maternity services. However, this data is largely quantitative in nature and provides little insight into women's lived mental and emotional experience of birth. Indeed, the national strategy itself recognizes that the maturity and effectiveness of existing administrative data sets can be improved to include the collection of woman-reported outcomes, wellbeing and experiences, e.g. using patient-reported experience and outcome measures.

State-based patient experience surveys

The New South Wales Maternity Care survey collects information from women who recently gave birth in a New South Wales public facility about the care they received. First undertaken in 2015, the survey is repeated every two years. The 2017 survey reflects the experiences of 4,787 women, representing 8% of approximately 62,000 women who gave birth in one of 71 NSW public hospitals in 2017. Results are reported at the hospital level where responses meet a pre-determined response threshold and all responses are incorporated into state-level reports (18). Survey questions relate to women's experiences of care in public hospitals during various stages of their maternity journey, from antenatal care, care during labour and birth, postnatal care in hospital and follow-up care at home. They relate directly to the national strategy values of safety, respect, choice and access (19).

Queensland undertakes a similar maternity care survey. The Maternity Patient Experience Survey includes a random selection of mothers who gave birth or received care after birth at Queensland public hospitals and birthing centres. Surveys were conducted in 2018-2019, 2016 and 2014-2015. The Maternity Outpatient Clinic Patient Experience Survey includes a random selection of mothers who attended a Queensland public hospital maternity specialist outpatient clinic. Surveys were conducted in 2017-2018 and 2015. For each survey, online facility level results provided to Hospital and Health Services (20). Summary results of the 2017 and 2015 Maternity Outpatient Clinic Patient Experience Survey and the 2014-2015 Statewide Maternity Patient Experience Survey Report are publicly available on the Queensland Health website (20). The 2014-2015 Maternity Patient Experience Survey includes the results of 4,977 interviews completed with mothers who received care in one of 38 facilities across Queensland. Facilities are grouped into five 'peer groups' that provide similar services, to allow for comparisons between facilities within each peer group (21). The survey covers a range of issues relating to women's experiences of antenatal and postnatal care in Queensland public hospitals and like the New South Wales Maternity Care survey there is strong alignment with the national strategy values of safety, respect, choice and access.

Other jurisdictions in Australia also have in place surveys to measure patient experience. Western Australia (22) and South Australia (23) employ randomized surveys to collect and measure data regarding patient experience, but none of these surveys relate specifically to consumers of maternity care. Victoria also employs randomized surveys to measure patient experience, but also includes specialized questionnaires for maternity clients. However, none of these surveys are as comprehensive or as widely reported as the New South Wales or Queensland surveys. Implementation of the New South Wales and/or Queensland Maternity Care survey methodology across Australia would go some way to ensuring that woman-reported outcomes of labour and delivery are represented in

national data collections. It would also be of significant utility as a source of woman-reported outcomes for inclusion as output variables in any assessment of the efficiency and productivity of maternity services in Australia.

International Consortium for Health Outcomes Measurement Pregnancy and Childbirth Standard Set

The International Consortium for Health Outcomes Measurement (ICHOM) is a not-for-profit organization that was established to promote and facilitate the global uptake of value-based health care. Value-based health care is a theoretical framework that places patients at the centre of care. It defines value as the ratio of outcomes of care divided by the cost of achieving those outcomes, where outcomes are defined as relevant end results of care from the perspective of the patient. To facilitate the implementation of value-based care, ICHOM works with international Working Groups of clinicians, researchers and patients to define standardized outcome measure sets (Standard Sets) for evaluating value in specific condition areas (24).

ICHOM has developed a Pregnancy and Childbirth Standard Set that identifies 24 outcome measures to evaluate care during pregnancy and up to 6 months postpartum. Specific outcome measures are grouped across four domains: Patient satisfaction with care; survival; morbidity; and patient-reported health and well-being. The Standard Set also includes a list of case-mix factors to allow comparison of outcomes across various patient populations. Table 3 shows the Pregnancy and Childbirth Standard Set outcomes mapped to four values outlined in Australia’s national maternity strategy, and identifies those outcomes that are more appropriately included in an efficiency and productivity analysis as cost adjustments.

Table 3: ICHOM Pregnancy and Childbirth Standard Set mapped to Australian national maternity strategy values

Measure	Safety	Respect	Choice	Access	Cost Adjustment
Maternal death	X				
Still birth	X				
Neonatal death	X				
Maternal need for intensive care	X				
Maternal length of stay	X				
Late maternal complication	X				
Transfusion	X				
Spontaneous pre-term birth	X				
Iatrogenic pre-term birth					
Oxygen dependence	X				
Neonate length of stay	X				
Birth injury	X				
Health related quality of life					X
Incontinence	X				
Pain with intercourse	X				
Success with breastfeeding			X		
Confidence with breastfeeding		X	X		
Mother-infant attachment		X			
Confidence with role as a mother		X			
Postpartum depression					
Satisfaction with the results of care		X	X		
Confidence as an active participant in healthcare decisions		X			
Confidence in healthcare providers		X			
Birth experience		X			

A number of the ICHOM measures broadly map to data items collected as part of Australia’s NPDC, such as those related to ‘Survival’, ‘Severe maternal morbidity’ and ‘Neonatal morbidity’. However, measures related to ‘Patient-reported health status’, ‘Role transition’, ‘Satisfaction with care’ and ‘Healthcare responsiveness’ capture directly women’s experiences of pregnancy and childbirth and have no equivalencies in Australia’s national maternal data collection.

Although the ICHOM Pregnancy and Childbirth Set is not utilized at a national level, a number of studies in Australia have verified its utility in measuring the mental and physical health of women during pregnancy and the postpartum period (25, 26). Implementation of the ICHOM Pregnancy and Childbirth Set in Australia would significantly enhance the national maternity data collection and provide a more comprehensive picture of how maternity services across the nation are delivering care in accordance with the values and principles of the national strategy. It would also allow more sophisticated and relevant analyses

of the efficiency and productivity of maternity services, allowing for the inclusion of output variables that directly relate to woman's experience of pregnancy and childbirth.

Constructing an output measure based on current data

Output measures for assessing efficiency and productivity of maternity services in Australia should ideally reflect the values and principles of woman-centred care. Australia's national maternity strategy clearly articulates Australia's vision for the provision of woman-centred maternity care based on the values of safety, respect, choice and access. This strategy therefore provides a useful framework to consider potential output measures for assessment of the efficiency and productivity of maternity services in Australia. Ideally, any efficiency and productivity analysis would incorporate output measures that correlate with and indicate how well a maternity service is delivering care in accordance with these values. They should also be able to be applied nationally, using data that is collected and accessible in every state and territory.

With these principles in mind, we have constructed a composite output measure that can be used in assessing the efficiency and productivity of maternity services in Australia. This composite measure consists of antenatal, labour and birth and birth outcomes indicators where data is available from the National Perinatal Data Collection. These measures are shown in Table 4 and are mapped against the four values of Australia's national maternity strategy: safety; choice; respect; access.

Table 4: Composite output measure for assessing maternity service efficiency and productivity in Australia

Composite Measure (number of births)	Values of women-centred maternity care			
	Safety	Respect	Choice	Access
<i>Labour and birth indicators</i>				
Birth status: Live Birth	X			
Labour onset type: Spontaneous	X		X	
Birth event: Vaginal, non-instrumental, nil episiotomy	X		X	
Gestational age 37 weeks or greater	X			
<i>Birth outcome indicators</i>				
Apgar score of more 7 or more at 5 minutes for births at or after term	X			
Birthweight >2,500 grams	X			
Postpartum perineal status: Intact or 1 st degree laceration/vaginal graze or 2 nd degree laceration	X			

Discussion

The composite outcome measure put forward by this paper is constructed from antenatal, labour and birth and birth outcomes indicators where data is available from the National Perinatal Data Collection, mapped against the four values of Australia's national maternity strategy: safety; choice; respect; access. The value in constructing a composite output measure is that it captures multiple outcomes that are representative of the provision of woman-centred care – it represents the birth experience that should be attainable for the majority of women. Whilst recognizing that for some women attainment of these outcome measures would be inappropriate or unachievable, composite outcome measures nevertheless provide a useful measure of the overall performance of a maternity service in delivering 'best practice' women-centred care across multiple dimensions. However, as is evident from Table 4, the individual indicators in this composite outcome measure map largely to the values of safety and very little to the values of respect, choice or access. The current Australian national maternity data collections are largely quantitative in nature and provide little insight into women's lived mental and emotional experience of birth. At a state level, only two states routinely deliver and report woman-reported maternity experiences. Within Australia there is therefore no national data available that provides any specific indication of how well maternity services are performing in delivering woman-centred maternity care.

Conclusion

This composite measure developed in this paper makes it very clear that there are significant gaps in Australia's maternity data collections with regard to measuring how well a maternity service is performing against the values of respect, choice and access. Adoption in Australia of the collection of woman-reported maternity outcomes would substantially strengthen Australia's national maternity data collections and provide a more holistic view of pregnancy and childbirth in Australia beyond traditional measure of maternal and neonate morbidity and mortality. Widespread adoption of across Australia of maternity care surveys, such as those conducted in New South Wales or the implementation of the ICHOM Pregnancy and Childbirth Standard Set would go some way to providing a more comprehensive and nuanced assessment of how well Australian maternity services are performing in the delivery of woman-centred care.

This would provide a substantial foundation upon which to develop a sophisticated analysis of the efficiency and productivity of maternity services in Australia and their performance in providing woman-centred care as outlined in the national maternity services strategy.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and materials

Not applicable. Data sharing is not applicable to this article as no datasets were generated or analysed during the current study. *Competing interests*

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author's contributions

Bonnie Ekloom: Conceptualization, Investigation, Writing – Original Draft **Emily Callander:** Writing – Review & Editing, Supervision **Sally Tracy:** Writing – Review & Editing

Acknowledgements

Not applicable

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