# Supplementary materials

## Contents

## Structured abstract

**Background.**

Progress towards universal health coverage requires evidence based policy and price setting informed by good quality cost data systems. Establishing these systems can be complex and both resource and time intensive. and there is little documentary evidence of experiences building such systems in low-and-middle income countries (LMICs).

**Objectives.**

To synthesise evidence on the experiences of LMICs in institutionalizing cost data systems in order to derive lessons for the technical process of price-setting in the context of UHC goals.

**Eligibility criteria.**

Studies were included if they identified and/or described either the development of the national tariffs and/or the methods used to estimate or inform the tariffs for hospital services reimbursement.

**Sources of evidence,**

English-language publications since 2000 indexed in Pubmed, Medline, Econlit and the Web of Science.

**Charting methods.**

Papers were classified according to whether they explained the technical process of price-setting for reimbursements and whether they reported on the process of primary cost data collection for price-setting. We extracted information on cost data collection methods, outputs and commentary on how cost data was used as well as descriptions of the technical aspects of the tariff setting system and key strengths and challenges. A narrative review approach was used to summarise the evidence by country. Data extraction was performed by one reviewer and then checked by a second reviewer.

**Results.**

A total of 484 papers were initially identified of which 30 papers were considered eligible. Fourteen papers reported on primary cost data collection for price-setting purposes; 18 papers provided an

explanation of how cost evidence informs tariff-setting. Documented experience is largely focussed in the Asia region (n = 22) with countries at different stages of developing cost systems to inform tariff setting. Country experiences on healthcare cost accounting tend to showcase country costing experiences, methods and implementation. There is little documentation of how cost data has been incorporated into decision making and price setting. Where cost data, cost systems and costing has been used, improved transparency in decision making alongside increased service provision efficiency has followed.

**Conclusions.**

Countries need to build sustainable cost systems appropriate to their settings and budgets and adopt transparent processes and methodologies for translating costs into prices.

## Table S1. Search strategy

| Database | Search terms |
|---|---|
| **Web of Science** | (ALL=(("case*mix" or "cost systems" or "cost*accounting" or "ref*costs" or "resource weights" or "cost*weights" or "national reimbursement" or "DRG" or "hospital payment systems" or "fee*for*service"))) AND ALL=("LMIC" OR "low resource settings" OR "developing countries") |
| **Econlit** | ("case*mix" or "cost systems" or "cost*accounting" or "ref*costs" or "resource weights" or "cost*weights" or "national reimbursement" or "DRG" or "hospital payment systems" or "fee*for*service").mp. [mp=heading words, abstract, title, country as subject]<br><br>No hits when combined with lmics |
| **Medline** | 1. ("case mix" or "DRG" or "case based payment" or "hospital payment system" or "reimbursement" or "resource value unit" or "cost systems" or "cost accounting" or "reference costs" or "resource weights" or "cost weights" or "Price setting" or "service weights")<br>2. "Costs and Cost Analysis"/ or National Health Programs/ or diagnosis-related groups/ or hospitalization/<br>3. 1 OR 2<br>4. Developing Countries/<br>5. "universal health*<br>6. Universal Health Insurance/ or "Delivery of Health Care"/ or Insurance, Health/<br>7. 5 OR 6<br>8. 3 AND 4 AND 7 |
| **PubMed** | ("reference cost*" OR "reference price*") AND health* AND national* AND list*)<br>Since 2000 |

## Table S2. List of studies identified and included in the review

| Author | Year | Country | Aim of paper in relation to costing (rationale for inclusion) | Type of study | Cost data reported | Comments on country's cost system |
|---|---|---|---|---|---|---|
| Langebrunner JC et al | 2009 | LMIC (Kazakhstan, Kyrgyzstan) | Manual on methods for setting up provider based systems; provides methods and case study of costing accounting for case based payments | Case studies | Yes | Yes |
| Joint Learning Network | 2014 | LMIC | Costing specific resource for lmics | Case studies | Yes | Yes |
| Martin A | 2012 | Cambodia | Costing in Cambodian hospital | Primary (cost data) | Yes | Yes |
| Ministry of Health, Republic of Indonesia | 2012 | Indonesia | Report on a costing study for Indonesia | Primary (cost data) | Yes | Yes |
| Ghaffari S et al | 2009 | Iran | Costing for DRGs in Iran | Primary (cost data) | Yes | Yes |
| Mathauer I | 2011 | Kenya | Role of costing in setting insurance reimbursement rates in Kenya | Literature review | Yes | Yes |
| Jadoo SAA et al | 2015 | Malaysia | Documenting the development of DRG cost weights in pharmacy in Malaysia | Primary (cost data) | Yes | Yes |
| Dianingati JK et al | 2019 | Indonesia | Single site cost data collection to inform price setting | Primary (cost data) | Yes | Yes |
| Jacobs B et al | 2019 | Cambodia | Multiple site cost data collection to inform national policy including reimbursement rates | Primary (cost data) | Yes | Yes |
| Ocharot L et al | 2016 | Thailand | Cost implications of adverse events in DRG system | Primary (cost data) | Yes | Yes |
| Prinja S et al | 2021 | India | Comparing cost data with reimbursement rates in ABPMJAY, India | Primary (cost data) | Yes | Yes |
| Riewpaiboon, A. et al | 2012 | Thailand | Development of Relative Value Units for Unit Cost analysis of Medical Services in Thailand | Primary (cost data) | Yes | Yes |
| Vo TQ et al | 2018a | Vietnam | Development of Relative Value Units for Unit Cost analysis of Medical Services in Vietnam | Primary (cost data) | Yes | Yes |
| Vo TQ et al | 2018b | Vietnam | Comparison of hospital costing methods in Vietnam | Primary (cost data) | Yes | Yes |
| Dianingati RS et al | 2021 | Asia | Literature review of medical service costs in Asia | Literature review | Yes | No |
| Jassim AL et al | 2011 | India | Testing for RVU method for costing in hospitals in India | Primary (cost data) | Yes | No |
| Chatterjee S et al | 2013 | India | Hospital costing study | Primary (cost data) | Yes | No |
| Stenberg K et al | 2018 | Global | Estimating unit costs of health services at a country level based on global dataset | Primary (cost data) | Yes | - |
| Lian LL et al | 2014 | Taiwan | Assessing incentives in DRGs | | No | Yes |
| Barber S et al | 2019 | Global (India, Malaysia, Thailand) | Manual and case studies on price setting for case-based payment | Case studies | No | Yes |
| Bredenkamp C et al | 2020 | Global (China, Kyrgyz Republic, Thailand) | Case studies of DRG transitions | Case studies | No | Yes |

| Author | Year | Country | Aim of paper in relation to costing (rationale for inclusion) | Type of study | Cost data reported | Comments on country's cost system |
|---|---|---|---|---|---|---|
| Zhao C et al | 2018 | China | Document China's experiences with shifting to case based payment schemes | Case studies | No | Yes |
| Prinja S et al | 2020 | India | Commentary on cost data for policy | Commentary | No | Yes |
| Mathauer I et al | 2013 | LMIC | Literature review of DRG experiences in LMICs | Literature review | No | Yes |
| Doshmangir L et al | 2020 | Iran | To document Iran's experience of tariff setting | Primary | No | Yes |
| Hoang VM, et al | 2014 | Vietnam | Reporting on costing in Vietnam for provider payment reform | Primary | No | Yes |
| National Health Authority | 2019 | India | Describes process of updating HBP package rates | Primary | No | Yes |
| Patcharanarumol K et al | 2018 | Thailand | Comparing strategic purchasing in two financing schemes | Primary | No | Yes |
| Rasiah, D et al | 2011 | Malaysia | Comparing methods for costing of health services in Malaysia | Primary | No | Yes |
| KPMG | 2019 | India | Overview of AB-PMJAY reform and financing mechanisms | Report | No | Yes |
| Barber S et al | 2020 | Global | To provide policy recommendations on estimating the cost of UHC | Case studies | No | Yes |
| Wagstaff A et al | 2007 | East Asia | Lessons learned in Asia for financing reforms including provider payment | Primary | No | Yes |
| Hu S et al | 2008 | China | Commentary | Commentary | No | No |
| Zeng W et al | 2018 | Global | Examining role of PBF in strengthening health systems | Commentary | No | No |
| Beck E et al | 2012 | LMIC | Describes the financial information required by policy makers and other stakeholders to enable them to make evidence-informed decisions and reviews the quantity and quality of the financial information available, | Literature review | No | No |
| Zou K et al | 2020 | China | Literature review of impact of case based payments in China | Literature review | No | No |
| Bertram M et al | 2017 | Global | Estimating unit costs for disease control programmes | Primary | No | No |
| Immunisation Costing Action Network | 2018 | LMIC | Costing of immunisation programmes | Primary | No | No |
| Jian W et al | 2016 | China | Assessing capacity of information system to implement DRGs (not cost system) | Primary | No | No |
| Watkins D et al | 2020 | LMIC | Resource requirement estimation of model health benefit packages (essential services) | Primary | No | No |

## Table S3. Costing evidence for tariff setting in hospital payment schemes in LMICs

| Year | Author | Country/ Region | Type of study | Method of cost data collection | Generated output (what form does the cost data take e.g. Unit costs, DRG cost weights, base rates) | What is/was the cost data used for or what is the intended use |
|---|---|---|---|---|---|---|
| 2021 | Prinja S et al | India | Primary (cost data) | Step down allocation; mix of top down and bottom-up costing | Reference costs to inform price setting and HTA | Comparison of health benefit package reimbursement rates with costs; use in HTA |
| 2021 | Dianingati RS et al | Asia | Literature review | Methods used in hospital cost analysis in Asia include direct allocation, step-down allocation, simultaneous equation allocations, micro costing and simplified activity-based costing. | Different final outputs include average costs, patient level (micro) costs, RVUs and RCCs. | Not reported for the studies in the review |
| 2019 | Jacobs B et al | Cambodia | Primary (cost data) | Step down allocation; bottom-up costing | Costs of health services | Initial phase of establishing a routine costing system for health services |
| 2019 | Dianingati JK et al | Indonesia | Primary (cost data) | Step down allocation: micro costing | Unit cost of the laboratory services of a district hospital in Indonesia | To compare actual costs of laboratory services with government established reference prices |
| 2018a | Vo TQ et al | Vietnam | Primary (cost data) | Step down allocation; Micro-costing | Relative value units (RVUs) for hospital services | Develop a set of RVUs for hospital services in Vietnam |
| 2018b | Vo TQ et al | Vietnam | Primary (cost data) | 1. Step down allocation; Micro-costing. 2. Hospital charges | Relative value units (RVUs) for hospital services | Comparison of different methods and identification of best method for the estimation of RVUs |
| 2018 | Stenberg K et al | Global | Primary | WHO-CHOICE service delivery unit costs based on regression analysis of country data sets | Cost per bed-day and cost per outpatient visit | Address cost information gap by producing standardised cost estimates that are comparable across countries |
| 2016 | Ocharot L et al | Thailand | Primary (cost data) | Hospital charges | Uncompensated adverse event costs for hospitalised patients | To demonstrate the cost implications of patient safety |
| 2015 | Jadoo SAA et al | Malaysia | Primary (cost data) | Step down allocation; bottom-up costing | DRG cost weights for pharmacy services | To identify the actual cost of pharmacy services by DRG case-mix group and inform reimbursement rates |
| 2014 | JLN | India Aarogyasri Hospital | Case study | Top down, direct and indirect costing for operating and capital costs.<br>For the cost of benefits packages a bottom-up approach was used. (4 hospitals; 42 procedures) | Costs of benefit packages | To set rates for 938 new benefit packages and revise estimates for pre-existing packages |

| Year | Author | Country/ Region | Type of study | Method of cost data collection | Generated output (what form does the cost data take e.g. Unit costs, DRG cost weights, base rates) | What is/was the cost data used for or what is the intended use |
|---|---|---|---|---|---|---|
| 2014 | JLN | Indonesia casemix | Case study | Top-down costing (137 hospitals) | Not specified | To estimate the cost of health services and construct cost weights for case based payments. |
| 2014 | JLN | Indonesia Health Facility | Case study | Top-down approach for both recurrent costs and capital costs. Bottom up approach to cost specific episodes of illness (200 hospitals) | Unit costs and episodes of illness | To estimate the production cost of services and drivers of cost variation among providers<br>Capitation payments |
| 2014 | JLN | Central Asian Republic | Case study | Predominantly top down, but also bottom up to obtain allocation statistics (15 hospitals) | Cost per bed-day by department | To estimate the cost per bed-day by cost centres to inform DRG weight coefficients<br><br>There was sufficient data available for top down costing which could be conducted in a relatively short period of time |
| 2014 | JLN | Malaysian DRG | Case study | Top-down approach to measure and value personnel, drugs/medical supplies, overheads, and capital resource use. Bottom up planned for ICU stays, laboratory tests and radiological interventions. (10 hospitals) | | To determine the cost of delivering health services in government hospitals to inform budgetary requirements<br><br>Top down approach was used most of the time, but for items that were heterogenous in their resource use or expensive a bottom up approach was more suitable |
| 2014 | JLN | India (PHFI) | Case study | Mixed method approach. Top down for the cost of resources consumed. Bottom up for personnel. (5 hospitals) | JLN costing exercise | PHFI used a mixed-method approach because data on resource use were not always available at the department level |
| 2014 | JLN | Phillipines | Case study | Analysis of claims. All tertiary hospitals. | | Cost of health services and specific disease categories |
| 2013 | Chatterjee S et al | India | Primary (cost data) | Step down allocation; bottom up costing | Cost per OP visit, cost per bed day; cost per emergency visit, cost per OT case | Informs hospital administrators, to improve efficiency and demonstrate the feasibility of hospital cost analysis in India |

| Year | Author | Country/ Region | Type of study | Method of cost data collection | Generated output (what form does the cost data take e.g. Unit costs, DRG cost weights, base rates) | What is/was the cost data used for or what is the intended use |
|---|---|---|---|---|---|---|
| 2012 | Riewpaiboon A. | Thailand | Primary (cost data) | 1. Reimbursement price list; 2. Bottom up/step down allocation; 3. Patient interviews | 1. RVUs; 2. inpatient base rate; 3. patient non-medical costs | To develop a list of standard unit costs of medical services for Thailand for HTA. |
| 2012 | Ministry of Health, Republic of Indonesia | Indonesia | Primary (cost data) | Step-down accounting methodology | For hospital services: cost per outpatient, cost per inpatient and cost per bed-day | To better understand the cost of delivering health services across the country and inform policy on geographic resource allocation, the development of hospital payment system and capitation formulae. |
| 2012 | Martin A | Cambodia | Primary (cost data) | Top down costing/step-down cost accounting (10 hospitals) | Average cost per discharge, per inpatient data and per outpatient visit by hospital department | To link costs with funding sources and document use of funds as well as inform the revision of the National Charter on Health Financing including provider payment reforms. |
| 2011 | Mathauer I | Kenya | Literature review | Most recent, multi-site costing studies<br>1. Bottom up, ingredients costing from (11 faith-based provider hospitals - ); 2. Step down cost accounting model (22 private for profit hospitals) | Cost per case (surgical, non-surgical and outpatients); cost per bed-day (surgical and non-surgical) | Costing information to inform resetting health insurance remuneration rates |
| 2011 | Jassim AL et al | India | Primary (cost data) | Step down allocation; process costing | Cost per relative value unit in support cost centres (e.g. laboratory) | To improve costing accuracy and provide guidelines for improved costing at the hospital level |
| 2009 | Ghaffari S et al | Iran | Primary (cost data); cost modelling | Primary: Step down allocation; ABC costing<br>Cost modelling: DRG cost weights imported from Australia | Relative value units, DRG costs and cost weights using indirect costs, direct care services and costs of care | To guide costing efforts for case mix funding models and identify optimal method for costing given data constraints. |
| 2009 | Langebrunner JC et al | Kyrgyzstan | Case studies | Cost accounting: Step down cost allocation to departmental level, Adapted from US medicare cost reports (initially 1 public hospital) | Cost per bed day and cost per case | Informed case base payment rates in DRG system |