Health Service Use and Costs Associated with Low Birth Weight—A Population Level Analysis

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Objectives To examine differences in health services utilization (HSU) costs in the first year of life between low birth weight (LBW) and normal birth weight (NBW) infants, identify maternal and child characteristics associated with HSU costs, and estimate annual HSU cost of LBW infants for the province of Alberta, Canada.

Study design A retrospective cohort study including all live births between 2004 and 2010. Data from the Alberta Perinatal Health Program database were linked to health care administrative data including inpatient, outpatient, and practitioner claims to identify HSU within the first year of life.

Results One-year HSU costs among LBW infants (n = 16 209) were $33 096 compared with $3942 among NBW infants (n = 189 586). There was a strong negative correlation between HSU costs and increasing birth weight, with health care costs among extreme LBW (<1000 g), very LBW (1000 and 1499 g), and moderate LBW (1500 and 2499 g) of $117 000, $84 000, and, $20 000, respectively. Maternal characteristics such as high prepregnancy weight, aboriginal status, and lower socioeconomic status were associated with higher HSU costs among the infants. LBW accounted for 7% of all infants but 37% of the total costs, amounting to $108 million annually.

Conclusions Compared with NBW infants, LBW infants consume more health resources not only in terms of initial hospitalization but also of re-hospitalizations, outpatient, and physician visits during the first year of their life. Interventions targeting social determinants of health are required to improve birth weight outcomes in Alberta. *(J Pediatr 2015;167:551-6)*.

Being an indicator for international comparison of population health status, low birth weight (LBW) (<2500 g) is an important public health issue in any country. LBW can be a result of prematurity (<37 weeks of gestation) and/or small for gestational age (SGA) (<10th percentile of babies born at the same gestational age and sex). LBW babies are more likely to experience adverse health and developmental outcomes with profound short- and long-term impact/implication on individual, family, health care system, and society.[1]

There are approximately 350 000 babies born in Canada each year, of which 6% are LBW.[2] In Alberta, a province in the west of Canada with a population of approximately 4 million,[3] these numbers are 45 000 babies and 7%, respectively.[4] Prematurity accounts for the majority of LBW, and its rate is on the rise in Canada. From 1995 to 2005, the rate of preterm births increased from 7% to 8.2%.[4] In 2008, Alberta's prematurity rate was higher than the country's average (eg, 8.8% vs 7.9%).[5]

Hospital costs associated with the birth event (index hospitalization) increase as birth weight and/or gestational age decrease.[6,7] In Canada in 2005-2006, the average hospital costs per newborn varied from $1000 for those with birth weight >2500 g to $117 000 for those with birth weight <750 g.[7] For singleton newborns, those born at gestational age <28 weeks have the highest cost ($84 000) and longest lengths of stay (83 days), compared with full-term births at or over 37 weeks of gestation ($1100 and 2 days, respectively).[7] However, less is known about the downstream costs, especially in the outpatient setting, beyond the index hospitalization, associated with LBW.

Accordingly, we performed this study to examine differences in cumulative costs and health services utilization (HSU) of inpatient, outpatient, and physician services, between LBW and normal birth weight (NBW) infants in the first year of life,

APHP	Alberta Perinatal Health Program
ELBW	Extremely LBW
HSU	Health services utilization
ICD	*International Classification of Disease*
LBW	Low birth weight
MLBW	Moderately LBW
NBW	Normal birth weight
NICU	Neonatal intensive care unit
SGA	Small for gestational age
VLBW	Very LBW

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identify maternal and child characteristics associated with HSU costs, and determine the health care cost burden of LBW infants in the province of Alberta.

Methods

For this study, we linked data from the Alberta Perinatal Health Program (APHP),[8] with the following administrative databases using the patient's personal health number: the Discharge Abstract Database, the Ambulatory Care Classification System, the Practitioner Payments (Fee-for-service Claims) Databases, the Alberta Health Care Insurance Population registry, and the vital status database.[9] This study was granted ethical approval by the University of Alberta (Pro00045611).

Established in 2004, APHP is a provincial perinatal program aiming to achieve optimal health for mothers and infants born in Alberta. APHP collects pregnancy and birth data from all facilities where women delivered and from Registered Midwives throughout Alberta. The Discharge Abstract Database is morbidity data and the Alberta version of the Canadian Institute of Health Information (www.cihi.ca) Discharge Abstract Database, which contains information on the recipient, service, diagnosis, and procedure interventions for people who have been discharged from an inpatient bed. There are 25 diagnostic code fields for each discharge abstract, and *International Classification of Disease* (ICD) *10th Revision* codes have been used since 2002.[10] The Ambulatory Care Classification System contains facility-based ambulatory care information regarding recipient, service, diagnosis, and procedure interventions. An ambulatory service is defined as any contact with a health service provider who treats patients not requiring an inpatient stay. Examples include same-day surgery, day procedures, emergency room visits, and community rehabilitation program services occurring in publicly funded facilities. There are 10 diagnostic code fields for each record, and ICD 10th Revision codes have been used since 2002. The Practitioner Payments Database includes fee-for-service claims by physicians and other providers for insured health services. This database contains information on the recipient, provider, and service. There are 3 diagnostic code fields for each claim, and ICD Ninth Revision codes have been used to date. The Alberta Health Care Insurance Population Registry was used to identify maternal residence in Alberta,[9] and the Vital Statistics database provided mortality data on out of hospital deaths as of December 31, 2009.[9] The data were linked to the 2006 Census of Population to obtain neighborhood-level information on household income.[11]

The patient population consisted of all live births (defined as births with any sign of life) between 2004 and 2010 recorded in the APHP database that was linked to the inpatient, outpatient, and practitioner payments databases. Those who were not linkable or missing information about birth weight and/or gestational age were excluded. When addressing our first 2 objectives of examining differences in HSU and costs among LBW and NBW infants and identifying maternal and child characteristics associated with HSU costs, we excluded NBW babies who were SGA or preterm. However, these were included in our analysis to address our third objective to determine the health care cost burden of LBW infants in the province of Alberta.

Primary outcomes of interest were HSU and HSU cost, which included 3 components: inpatient, outpatient, and practitioner services in the first year of live births. The costs reflect costs to the payer. In economic terms, we used a health system perspective and 1-year time horizon. We estimated the average numbers of hospitalizations, hospital days, neonatal intensive care unit (NICU) days, outpatient visits (separately between emergency and other outpatient visits), and practitioner visits (separately among general practitioners/family physician, pediatrician, and other specialist visits) for LBW in comparison with NBW. The HSU costs for inpatient services based on Case Mix Group Plus and for outpatient services based on Ambulatory Care Classification System Group were retrieved from Alberta Ministry of Health.[12] The costs for practitioner services were the total amount paid for claims made by practitioners recorded in the Practitioner Payments Database.

LBW was defined as birth weight <2500 g, moderately LBW (MLBW) as 1500-2499 g, very LBW (VLBW) as 1000-1499 g, extremely LBW (ELBW) as <1000 g, preterm as <37 weeks of gestation, and SGA as birth weight <10% compared with babies of the same gestational age and sex.[13] The standard birth weight by gestational age and sex was retrieved from Kramer et al.[14] Babies with congenital anomalies were those who had at least one of the diagnostic codes of congenital anomalies (**Table I**; available at www.jpeds.com) in any diagnostic fields of the databases.

Because the aim is to study HSU cost, we did not consider infant death as an outcome, but as an independent variable to determine if infant death is associated with HSU cost. Maternal characteristics were chosen based on associations with LBW reported in the literature[2] and based on their availability in the databases. We included age, weight, height, parity (number of previous live births), smoking during pregnancy, pre-eclampsia or eclampsia, gestational diabetes, ethnicity, socioeconomic status, and history of HSU (number of hospital days and outpatient visits) in 1 year prior to delivery. Socioeconomic status is based on neighborhood-level median household income from census data.[15]

We used both univariate and multivariate analyses to compare the HSU, HSU cost, and maternal and child characteristics between LBW and NBW infants. In the univariate analysis, *t* Student test was used for comparison of the means of continuous variables and χ^2 test for comparison of the proportions of binary and categorical variables. In the multivariate analysis, as HSU costs were skewed, we used a generalized linear model with HSU cost as the dependent variable following a gamma distribution and maternal and child characteristics as independent variables. The generalized linear model assumed an identity link between mean HSU and