Appendix

Cost analysis

The goal of analysis was to measure the costs of both operative and transcatheter device closure procedures. Costs (in comparison to charges) are generalizable between centers. Charges were extracted from CHOP data warehouse with assistance from the CHOP Center for Bioinformatics. Hospital bills contain line item charges for all diagnostic tests, therapeutics, supplies, and room fees as well as professional charges for procedures. Each charged item also lists its date, a unique service code, description of service, and the billing department to which it belonged. For each admission of interest, both hospital and professional charges (the amount billed to payers) were extracted, sorted by billing department. Hospital charges were converted to costs using RCCs generated by CHOP Finance that were department specific and specific to fiscal year.[18,19] No RCCs are available for professional charges, so no conversion was performed. All charges/costs were normalized to 2012 United States dollars (2012 US$) using consumer price index for medical care published by the Bureau of Labor Statistics.[20] This adjustment makes charges between years comparable and eliminates any potential bias from an uneven distribution of procedures over time.

Analysis of cost included direct medical costs (determined from hospital charges and professional charges) with time horizon restricted to hospitalization(s) during which ASD closure was performed. This time horizon was chosen because outpatient follow-up was not uniform at our institution. The effect of outpatient follow-up on differences in cost was addressed as described in the section in Methods on sensitivity analyses. The societal perspective was chosen. Preprocedural assessment of patients for both procedures is identical and composed of preprocedural outpatient visit, transthoracic echocardiogram, plain film chest radiograph, ECG, and laboratory testing for type and screen and complete blood count, so the costs were considered to be equivalent. Overhead costs were not included, and equal availability of cardiac surgical and interventional catheterization teams was assumed.

Propensity score

An important concern in an observational study is the risk of confounding by indication. During the study period, referring cardiologists in conjunction with families chose between transcatheter and operative closures of ASD at their discretion. Although operative cases were reviewed at weekly divisional conferences, there were no institutional protocols or criteria guiding referral. Before analysis, we suspected that baseline characteristics (age, height, weight, insurance payor, and prevalence of chronic medical conditions) might influence the choice between transcatheter and operative cohorts and/or influence cost of hospitalization. Wilcoxon rank sum, χ^2, and Fisher exact tests were used as appropriate to test for differences in the distribution of these factors. To account for confounding by indication, factors that were thought to affect the choice of closure method and cost were identified before analysis. These included patient age; height (centimeters); weight (kilograms); insurance payor; and presence of genetic syndrome, feeding tube, pulmonary disease, endocrine disease, or miscellaneous chronic medical conditions. From these, a propensity score was calculated[21] using the *pscore* command.[22] This defines a propensity score between 0 and 1 for assignment to transcatheter ASD closure and additional diagnostics. It automatically assigns the number of strata and allocates strata among the study population. It also performs checks that balancing and overlap are satisfactory. The resultant propensity score for each subject is included in subsequent multivariable analyses.

Multivariable models

Generalized linear models were used to account for measurable covariates (including propensity score weight) and compare cost between the 2 cohorts. A log gamma distribution was used to account for the skewed distribution of costs. Length of stay was also analyzed using a generalized linear model, but because LOS included zero as a possible value, a Gaussian probability distribution was used. For both multivariable models, conditional standardization was used to generate an adjusted estimate of the outcome of interest. Adjusted cost and LOS were estimated by setting continuous covariates to the study population mean, the propensity score set to 0.5, and categorical variables set to their referent values.

Sensitivity analyses

For each variable of interest, either the risk of an outcome (for crossover, reintervention, or 30-day acute care visits) or the cost of a visit (routine outpatient visits) was varied over a broad range. These analyses identify the point for each variable at which cost equality occurred between operative and transcatheter closures of ASD. Conceptually, the purpose of these analyses is to test the degree to which each variable potentially influences our conclusions regarding relative cost of procedures and how confident one should be in assessing conclusions based on a single study.[10]

Supplementary Table 1. Mixed effects multivariable model for cost of ASD closure including anatomic data on ASD in propensity score

	Relative Cost	95% CI	p
Device (vs. Surgery)	0.85	0.76-0.94	.002
Age (per year)	1.01	0.99-1.03	.56
Height (per cm)	0.995	0.99-1.00	.06
Weight (per kg)	1.004	1.00-1.01	.04
Payer (vs Medicaid)			
Medicaid	1	n/a	n/a
Private	0.97	0.89-1.07	.56
Self-pay	1.02	0.85-1.22	.82
Endocrine disorder	0.98	0.84-1.16	.85
Feeding tube	1.29	0.90-1.87	.17
Genetic syndrome	1.17	0.94-1.45	.17
History of prematurity	1.00	0.86-1.17	.99
Pulmonary disease	0.91	0.74-1.12	.38
Miscellaneous chronic medical condition	1.10	0.95-1.27	.19
Propensity score*	1.13	0.97-1.32	.11

* The propensity score is a number from 0-1 which reflects the probability of being referred for device closure, given the factors that were included in the original propensity score model.

Supplementary Table 2. Mixed effects multivariable model for cost of ASD closure with age divided into three categories

	Relative Cost	95% CI	p
Device (vs. Surgery)	0.93	0.86-0.997	.04
Age group			
Infant (<1 year)	1	n/a	n/a
Children (1-18 years)	0.71	0.52-0.98	.04
Adults (>18 years)	0.60	0.43-0.85	.004
Height (per cm)	1.00	1.00-1.01	.59
Weight (per kg)	10.00	1.00-1.01	.32
Payer (vs Medicaid)			
Medicaid	1	n/a	n/a
Private	1.01	0.91-1.11	.89
Self-pay	1.00	0.86-1.16	.96
Endocrine disorder	1.07	0.92-1.25	.40
Feeding tube	1.05	0.71-1.55	.80
Genetic syndrome	1.13	0.92-1.39	.23
History of prematurity	1.40	0.99-1.98	.06
Pulmonary disease	1.04	0.81-1.33	.77
Miscellaneous chronic medical condition	1.20	0.98-1.48	.07
Propensity score*	0.50	0.20-1.23	.040

* The propensity score is a number from 0-1 which reflects the probability of being referred for device closure, given the factors that were included in the original propensity score model.

Supplementary References

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