A Trade-off Analysis of Routine Newborn Circumcision

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Abstract. ***Background.*** **The risks associated with newborn circumcision have not been as extensively evaluated as the benefits.**

Objectives. **The goals of this study were threefold: 1) to derive a population-based complication rate for newborn circumcision; 2) to calculate the number needed to harm for newborn circumcision based on this rate; and 3) to establish trade-offs based on our complication rates and published estimates of the benefits of circumcision including the prevention of urinary tract infections and penile cancer.**

Methods. **Using the Comprehensive Hospital Abstract Reporting System for Washington State, we retrospectively examined routine newborn circumcisions performed over 9 years (1987–1996). We used *International Classification of Diseases, Ninth Revision* codes to identify both circumcisions and complications and limited our analyses to children without other surgical procedures performed during their initial birth hospitalization.**

Results. **Of 354 297 male infants born during the study period, 130 475 (37%) were circumcised during their newborn stay. Overall 287 (.2%) of circumcised children and 33 (.01%) of uncircumcised children had complications potentially associated with circumcision coded as a discharge diagnosis. Based on our findings, a complication can be expected in 1 out every 476 circumcisions. Six urinary tract infections can be prevented for every complication endured and almost 2 complications can be expected for every case of penile cancer prevented.**

Conclusions. **Circumcision remains a relatively safe procedure. However, for some parents, the risks we report may outweigh the potential benefits. This information may help parents seeking guidance to make an informed decision. *Pediatrics* 2000;105:246–249; *newborn circumcision, complications, urinary tract infections.***

ABBREVIATIONS. UTI, urinary tract infection; NNT, number needed to treat; NNH, number needed to harm; CHARS, Comprehensive Hospital Abstract Reporting System.

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Routine circumcision of newborn infants remains controversial.[1–3] Although a recent policy statement by the American Academy of Pediatrics recommended that parents be given accurate and unbiased information regarding the risks and benefits of the procedure,[3] accomplishing this task of well informed consent is hindered both by the lack of precise information about potential harm and by the lack of clear ways to present this information.

The benefits of circumcision have been described in numerous previous studies using a variety of methodologies.[4–8] Reported benefits include reduction in the risk of penile cancer,[9] urinary tract infections (UTIs),[4,5] and sexually transmitted diseases.[10,11] Although the extent to which circumcision decreases the risk of each of these outcomes has been debated,[6,12–15] a consensus appears to be emerging that there are some small protective effects.[3]

These protective effects of circumcision (or any other therapy) can be meaningfully conveyed in terms of a number needed to treat (NNT). The NNT is calculated from the reciprocal of the absolute risk reduction associated with a given treatment.[16] In the case of circumcision, this number represents the number of children who would need to be circumcised to prevent 1 undesired outcome such as UTI.

Although NNTs inform both providers and patients of the benefits of a given therapy or procedure, by themselves the NNTs present only half of the pertinent equation. What is also needed to make an informed decision is the number needed to harm (NNH). By analogy to NNTs, NNHs are based on the absolute difference in complication rates between treatment and control groups and tell one in effect how many patients would need to be circumcised before an adverse event can be expected to occur. Taken together, NNTs and NNHs can be used to construct a framework of "trade-offs"; in essence, one can compute how many undesirable outcomes will be prevented per complication incurred. Trade-offs can be useful to patients and providers seeking to weigh the pros and cons of a given procedure.

Although existing data are sufficient to enable us to estimate the NNT with circumcision for given outcomes, the risks of the procedure have received considerably less attention, hindering our ability to calculate NNHs. Previous studies of newborn circumcision complications have reported rates be-

tween .19 and .60%, but because these data were either derived from single institutions or from the children of army recruits they are not population-based.[6,17,18] Therefore we undertook a large, retrospective, population-based cohort study of circumcision of newborn infants. Our goals were threefold: 1) to obtain population-based estimates of complications associated with circumcision; 2) to convert these complication rates into NNHs; and 3) to use these NNHs in conjunction with published data of the benefits of the procedure to develop a framework for presenting NNT versus NNH trade-offs to better inform both practitioners and parents about routine newborn circumcision.

METHODS

Data Source

We used the Comprehensive Hospital Abstract Reporting System (CHARS) to conduct a retrospective analysis of 9 years (1987–1996) of routine newborn circumcisions performed in hospitals throughout Washington State. The CHARS contains *International Classification of Diseases, Ninth Revision* diagnosis and procedure codes for all discharges from short-stay hospitals in Washington State including birth hospitalizations. Each patient is assigned a unique yet anonymous identifier, enabling the analysis of patient level data without compromising confidentiality.

Patients

A retrospective cohort was assembled by using the CHARS to identify all newborn male infants who had circumcision coded as a procedure during their birth hospitalization. We excluded children who had any other surgical procedure documented in the database to ensure that all surgical complications we discovered were appropriately attributable to the circumcision procedure. Using the unique patient identifiers, we ensured that our analysis counted individual patients who had 1 or more complications, and not simply complications themselves.

NNTs to Prevent Undesired Outcomes

Based on published reports in the literature, we calculated NNTs for several outcomes. In the case of UTI in the first year of life, the NNT is 100 based on data from previous cohort studies[19–21]; that is, 100 children need to be circumcised to prevent 1 UTI. For penile cancer, although the association with circumcision status remains controversial,[12,22–24] conservative estimates (based on life table analyses and assuming circumcision to be 100% effective at preventing penile cancer), suggest a NNT of 909.[24,25] Data for the reduction of the risk of human immunodeficiency virus exist, but have been derived from very different populations than US adults and have led to conflicting conclusions.[11,26,27] Data from a sexually transmitted disease clinic suggest that circumcision reduces the risk of contracting syphilis,[10] although results from a population-based study appear to refute this association.[28] Moreover, sexual behavioral practices remain the most important modifiable risk factor for sexually transmitted diseases.[3] Therefore, we focused on the potential role of circumcision in the prevention of UTIs and penile cancer. These 2 outcomes also usefully frame all others: UTI is the most prevalent serious outcome deemed modifiable through circumcision and penile cancer is the least prevalent one.

NNH Based on Adverse Events Related to Circumcision Procedure

We limited our analysis to complications coded only during the postpartum hospital stay, because the overwhelming majority of complications related to circumcision occur shortly after the procedure,[10,11,17,18] and because we could not ascertain whether children who were not circumcised during their initial newborn stay were not subsequently circumcised as outpatients. However, we did include children who were transferred from one hospital to another and thus were continuously hospitalized from birth. Based on previous reports of complications attributable to circumcision,[6,18,29–31] we searched for specific *International Classification of Diseases, Ninth Revision* codes during postpartum hospitalizations. These codes are presented in Table 1.

Analysis

χ^2 was used to compare proportions of circumcised and uncircumcised children with complications. Exact tests were used where indicated based on expected cell frequencies. Independent sample *t* tests were used to compare mean lengths of stay. NNH were calculated based on the reciprocal of the absolute risk difference between complications in the circumcised versus the uncircumcised cohorts. Trade-offs were calculated based on the number of complications that could be expected conditioned on circumcising 100 children to prevent 1 UTI and 909 children to prevent 1 case of penile cancer.

RESULTS

There were 354 297 male births during the study period. Of these, 130 475 (37%) had circumcision coded during the birth hospitalization and had no

TABLE 1. Complications Attributable to Newborn Circumcision Among Circumcised and Noncircumcised Males During the Birth Hospitalization

Complication (International Classification of Diseases, Ninth Revision)	Circumcised N = 130 475 n (%)	Not Circumcised N = 223 822 n (%)	NNH
Hemorrhagic			
Intraoperative bleeding (998.1)	209 (.16)	30 (.01)*	667
Hemorrhage control (399.8)	12 (.0009)	0*	11 111
Suture of artery, vein, vessel (393.0, 393.1, 393.2)	9 (.0007)	0*	14 286
Total	230 (.18)	30 (.01)*	588
Injury			
Penile repair (644.9)	23 (.02)	0*	5 000
Suture penile laceration (644.1)	29 (.02)	0*	5 000
Wound-penis (878.0, 878.1)	3 (.002)	1**	50 000
Reconstruction of penis (644.4)	1 (.0008)	0	125 000
Total	56 (.04)	1*	3 333
Infection			
Cellulitis-penis (607.2)	2 (.0008)	2 (.0009)	NA
All complications	287 (.22)	33 (.01)*	476

* $P < .001$; ** $P < .10$.

other procedures coded. Various complications occurred during the birth hospitalization, as summarized in Table 1. Overall, there were 287 complications (.2%) in the circumcised children and 33 (.01%) in the uncircumcised group. Circumcised children with any complication had significantly longer newborn stays than circumcised children without complications (mean: 2.81 days vs 2.26 days; $P = .003$) although the only single complication associated with an increased newborn stay was "suture penile laceration" (644.1; 7.0 days vs 2.26 days; $P < .001$).

Based on these findings, the aggregated NNH is 476: that is, some form of complication occurs in 1 out of every 476 children who are circumcised. The NNH for each of the separate complications is also displayed in Table 1.

The NNT versus NNH trade-offs, each representing a discrete comparison of a particular benefit and a particular harm, are summarized in Table 2. Overall, 1.14 immediate circumcision-related complications can be expected for every 6 UTIs prevented, and 1.90 complications can be expected for every case of penile cancer prevented.

DISCUSSION

Because circumcision is not a lifesaving procedure,[6] and its modest medical benefits may be offset by its complications, its indications are discretionary. Parents who opt to circumcise their child for religious or cultural reasons do so appropriately within this discretionary boundary. For those parents seeking objective medical advice regarding the procedure, our trade-off analysis is intended to provide parents and providers with a sense of the relative medical risks and benefits of the procedure.

Our study found an overall complication rate associated with newborn circumcision of approximately .20%, or 1 adversely affected child for every 476 boys circumcised. We believe this estimate to be an accurate reflection of the true complication rate, as it is based on a large and diverse patient sample, and it is consistent with 2 previous studies that reported rates of .19% and .20%[6,18] although it is significantly less than that of another which reported a rate of .60%.[17] In part, this inconsistency may be accounted for by the method of data collection as some of these studies involved chart reviews that may be more apt to discern minor complications not coded on discharge.

Beyond this summary of the overall complication rate, our analysis also provides separate NNH estimates for different kinds of complications, which is important because the complications clearly are not all of equal consequence, medically or emotionally. Similarly, the value placed on preventing a UTI in an infant or a case of penile cancer in late adult life also are best reported as 2 distinct NNT figures, for they too are not necessarily of equal consequence.

Parents' subjective weighing of the benefits of prevention and the harm of complications is fundamental to this decision-making process. Accordingly, we did not assign relative weights to the outcomes. Further, we believe that attempts to designate utilities for these outcomes—whether they be based on expert panels or community surveys—would be misguided. The weighing process in this decision should remain individualized and subjective, taking fully into account the parents' general degree of aversion to risk, and in particular whether the risk arises from either omitted or committed actions. Parents might well have greater feelings of guilt associated with adverse events arising from circumcision, such as needing a penile wound repaired, than from a different adverse and somewhat preventable event, such as a UTI, occurring in uncircumcised boys. This aversion to committed action risk and its associated feelings may counterbalance or outweigh any potential benefits.

Two specific limitations of this study warrant consideration. First, as with any large administrative database study, the records likely contain some

TABLE 2. Trade-off Analysis for Circumcision: Adverse Outcome Prevented per Complication Endured

Complication (International Classification of Diseases, Ninth Revision)	Trade-offs	
	Number of Complications Endured per Case of UTI Prevented	Number of Complications Endured per Case of Penile Cancer Prevented
Hemorrhagic		
Intraoperative bleeding (998.1)	.15	1.36
Hemorrhage control (399.8)	.01	.08
Suture of artery, vein, vessel (393.0, 393.1, 393.2)	.005	.64
Total	.16	1.55
Injury		
Penile repair (644.9)	.01	.18
Suture penile laceration (644.1)	.01	.18
Wound-penis (878.0, 878.1)	.002	.02
Reconstruction of penis (644.4)	.001	.007
Total	.03	.27
Infection		
Cellulitis-penis (607.2)	NA	NA
Total	.19	1.90

incorrect or missing codes. Because it is both common and reimbursable, circumcisions were likely to be accurately coded in the database when they were performed. However, at first glance, our reported circumcision rate of 37% may seem low. Unpublished estimates suggest circumcision rates of approximately 50% for the state of Washington. However, our data collection method would only capture children who were circumcised during their birth hospitalization and not those subsequently circumcised as outpatients. Nevertheless it is possible that circumcisions were performed but not coded as was possibly the case with the 1 uncircumcised boy for whom "penis wound" was coded. Misclassifications of this kind would have biased our findings toward the null. We attempted to control for other misclassifications, either other procedures performed but not coded as may have been the case for children with interoperative bleeding in the absence of other documented procedures or miscoding of complications, by using a comparison group of "uncircumcised" children. For misclassifications then to have meaningfully impacted our results, they would have to have occurred a greater proportion of the time in one group versus the other. There is no a priori reason to believe this to be the case.

Second, because our sample was limited to the immediate postbirth observation period, we did not capture the very rare but serious and delayed complications associated with circumcisions (eg, necrotizing fasciitis, cellulitis). Our analysis also did not capture the less serious but far more common "complications," such as the healthy but unsightly healing of a circumcision that often unnerves parents, or a less than ideal cosmetic result, either of which may lead parents to seek medical attention. Our results therefore represent conservative estimates of complications attributable to circumcision.

Overall, routine newborn circumcision appears to be a relatively safe procedure. It is not without some risks, however, and these risks do not seem to be mitigated by the hands of more experienced physicians.[32] Given that these risks then are likely to remain, we hope that the methods we used to present both the risks and the benefits as trade-offs are both meaningful and helpful.

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REFERENCES

1. Anonymous. Position statement: routine circumcision of normal male infants and boys. *Aust Coll Paediatr.* 1996
2. Anonymous. Neonatal circumcision revisited. Fetus and Newborn Committee, Canadian Paediatric Society. *Can Med Assoc J.* 1996;154:769–780
3. Task Force on Circumcision. Circumcision policy statement. *Pediatrics.* 1999;103:686–693
4. To T, Agha M, Dick PT, Feldman W. Cohort study on circumcision of newborn boys and subsequent risk of urinary-tract infection. *Lancet.* 1998;352:1813–1816
5. Wiswell TE, Smith FR, Bass JW. Decreased incidence of urinary tract infections in circumcised male infants. *Pediatrics.* 1985;75:901–903
6. Wiswell TE, Geschke DW. Risks from circumcision during the first month of life compared with those for uncircumcised boys. *Pediatrics.* 1989;83:1011–1015
7. Craig JC, Knight JF, Sureshkumar P, Mantz E, Roy LP. Effect of circumcision on incidence of urinary tract infection in preschool boys. *J Pediatr.* 1996;128:23–27
8. Ginsberg CM, McCracken G. Urinary tract infections in young infants. *Pediatrics.* 1982;69:409–412
9. Schoen E. The relationship between circumcision and cancer of the penis. *CA Cancer J Clin.* 1991;41:306–309
10. Cook LS, Koutsky LA, Holmes KK. Circumcision and sexually transmitted diseases. *Am J Public Health.* 1994;84:197–201
11. Bwayo J, Plummer F, Omari M, et al. Human immunodeficiency virus infection in long-distance truck drivers in East Africa. *Arch Intern Med.* 1994;154:1391–1396
12. Fleiss PM, Hodges F. Neonatal circumcision does not protect against penile cancer. *Br Med J.* 1996;312:779–780
13. Schoen EJ. Benefits of newborn circumcision: is Europe ignoring medical evidence? *Arch Dis Child.* 1997;77:258–260
14. Schoen EJ. Neonatal circumcision and penile cancer. Evidence that circumcision is protective is overwhelming. *Br Med J.* 1996;313:46
15. Van Howe RS, Cold CJ. Advantages and disadvantages of neonatal circumcision. *JAMA.* 1997;278:203
16. Cook R, Sackett D. The number needed to treat. *Br Med J.* 1995;310:452–454
17. Harkavy K. The circumcision debate. *Pediatrics.* 1987;79:649–650
18. Gee WF, Ansell JS. Neonatal circumcision: a ten-year overview: with comparison of the Gomco clamp and the Plastibell device. *Pediatrics.* 1976;58:824–827
19. Wiswell TE, Hachey WE. Urinary tract infections and the uncircumcised state: an update. *Clin Pediatr (Phila).* 1993;32:130–134
20. Wiswell TE, Roscelli JD. Corroborative evidence for the decreased incidence of urinary tract infections in circumcised male infants. *Pediatrics.* 1986;78:96–99
21. http://weber.u.washington.edu/~ebm/topic/CATS/circumcision.html
22. Stanton A. Neonatal circumcision and penile cancer. Authors ignored main conclusion of study that they cited. *Br Med J.* 1996;313:47
23. Schoen EJ. Neonatal circumcision and penile cancer. Evidence that circumcision is protective is overwhelming. *Br Med J.* 1996;313:46; discussion 47
24. Swafford TD. Circumcision and the risk of cancer of the penis. *Am J Dis Child.* 1985;139:112
25. Mosze KSM. Circumcision and cancer of the penis. *Am J Dis Child.* 1980;134:484–486
26. Urassa M, Todd J, Boerma JT, Hayes R, Isingo R. Male circumcision and susceptibility to HIV infection among men in Tanzania. *AIDS.* 1997;11:73–79
27. Barongo LR, Borgdorff MW, Mosha FF, et al. The epidemiology of HIV-1 infection in urban areas, roadside settlements and rural villages in Mwanza Region, Tanzania. *AIDS.* 1992;6:1521–1528
28. Laumann EO, Masi CM, Zuckerman EW. Circumcision in the United States. Prevalence, prophylactic effects, and sexual practice. *JAMA.* 1997;277:1052–1057
29. Anday EK, Kobori J. Staphylococcal scalded skin syndrome: a complication of circumcision. *Clin Pediatr (Phila).* 1982;21:420
30. Bliss DP Jr, Healey PJ, Waldhausen JH. Necrotizing fasciitis after Plastibell circumcision. *J Pediatr.* 1997;131:459–462
31. Neulander E, Walfisch S, Kaneti J. Amputation of distal penile glans during neonatal ritual circumcision—a rare complication. *Br J Urol.* 1996;77:924–925
32. Moreno C, Realini J. Infant cirumcision in an outpatient setting. *Tex Med.* 1989;85:37–40

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