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Rates of Adverse Events Associated with Male Circumcision in U.S. Medical Settings, 2001 – 2010

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Abstract

Importance—Over 1.4 million male circumcisions are performed annually in U.S. medical settings. However, population-based estimates of male circumcision associated adverse events are lacking.

Objectives—To estimate the incidence rate of male circumcision associated adverse events, and assess whether adverse event rates differed by age at circumcision.

Design—We selected 41 possible male circumcision adverse events based on literature review and medical billing codes. We estimated a likely risk window for incidence calculation for each

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Charbel El Bcheraoui and Xinjian Zhang had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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male circumcision adverse event based on pathogenesis. We used 2001 – 2010 data from SDIhealth, a large administrative claims dataset, to conduct a retrospective cohort study.

Setting—SDIhealth provided administrative claims data from inpatient and outpatient U.S. medical settings.

Main outcome measures—For each adverse event, we calculated incidence per million male circumcisions. We compared incidence risk ratio and incidence rate difference for: a) circumcised vs. uncircumcised newborn males, and b) males circumcised at ≤1 year, 1–9 years, or ≥10 years of age. An adverse event was considered probably related to male circumcision if the incidence risk ratio significantly exceeded one at $p<0.05$ or occurred only in circumcised males.

Results—Records were available for 1,400,920 circumcised males, 93.3% as newborns. Of the 41 possible male circumcision adverse events, 16 (39%) were probable. Incidence of total male circumcision adverse event was slightly less than half percent. Rates of potentially serious male circumcision adverse events ranged from 0.76 per million male circumcision (95% CI: 0.10 – 5.43) for stricture of male genital organs to 703.23 per million male circumcision (95% CI: 659.22 – 750.18) for repair of incomplete circumcision. Compared to males circumcised at ≤1 year of age, the incidence was approximately 20- and 10-fold greater for males circumcised between 1 – 9 years and those ≥10 years of age, respectively.

Conclusions and Relevance—male circumcision had a relatively low incidence of adverse events overall, especially if the procedure was performed during the first year of life, but rose 10–20 fold when performed after infancy.

Keywords

adverse events; male circumcision

Introduction

The American Academy of Pediatrics (AAP) updated its guidance on male circumcision (MC) in 2012 to state “the procedure’s benefits justify access to this procedure for families who choose it.”[1] Whether MC should be considered an important public health intervention in the United States and other developed countries based on results of three randomized controlled trials[2–4] showing its HIV protective effect has been debated.[5–8] A key aspect of this debate is the rate of adverse events (AE), especially serious ones, attributable to MC, both for males circumcised as infants, and those undergoing voluntary circumcision as adults/adolescents.

Several studies have reported on MC AE, from mild to severe, ranging from 0.0008% to 3.6% in infants and from 0.9% to 8.8% in adults.[9–21] However, most of these studies[22] were based on relatively small samples, one clinical site or state, cross-sectional data or non-representative cohorts. While the Weiss review [22] and one case series describing the experience of one pediatric urologist conducting Gomco circumcision in 150 neonates and infants[23] suggested generally higher rates of AE with older age at MC, to our knowledge, none have compared rates of AE across all age groups at MC from neonatal to adults in the same study. To provide stakeholders with better population-based information on the risk of

MC AE, we use a large administrative claims dataset to 1) estimate the incidence rate of AE associated with MC via comparison of incidence risk ratio (IRR) and incidence rate difference (IRD) of AE between circumcised and uncircumcised newborn males, and 2) compare the IRR and IRD of AE associated with MC across age groups (≤1 year, 1 – 9 years, and ≥10 years).

Methods

SDIhealth (Plymouth Meeting, PA) consolidates U.S. electronic healthcare reimbursement claims. SDIhealth data include International Classification of Diseases, 9th revision (ICD-9) and Current Procedural Terminology (CPT) codes, and are available about two months after clinical visits. SDIhealth creates a unique anonymous identifier for each patient, enabling individuals to be followed longitudinally.

The Charge Data Master (CDM) is SDIhealth's inpatient dataset. It gathers data from a 20% convenience sample of all inpatient encounters of short-stay, acute care, and non-federal hospitals from 48 states and Washington DC, representing ~120 million unique hospitalized patients. CDM hospitals are located in all U.S. regions (25% East, 12% North, 45% South, 16% West, and data on regions is unspecified for 2%). Of these hospitals, 85% are urban, 36% are teaching, with a wide variability of bed-size (median size 200–299 beds). Of patients seen at these hospitals, about 10% of patients are covered by Medicaid, 30% by Medicare, and the remainder covered by Third Party payers. CDM data is formed by two datasets: CDM1 (~80% of CDM) is available since 2001 and updated monthly; only the month of diagnosis or procedure is provided, with date of discharge defaulted to the first day of the discharge month. CDM2 (~20% of CDM), is available since 2005 and updated weekly; unlike CDM1, the exact discharge date of a diagnosis or a procedure is available. SDIhealth also collects data from >870,000 unique outpatient medical providers with the exact discharge date of diagnoses and procedures. For this study, we used CDM data available through February 2010.

Possible MC AE for this analysis were first identified from a review of a) PubMed using the search terms "circumcision" and "adverse events," and b) the ICD-9 and the CPT manuals for conditions that are not necessarily due to, but could be related to MC. Our search yielded 41 possible MC AE that we classified into ten clinical syndromic groups (eTable 1).

For each of the 41 possible MC AE, one of the co-authors who is a board-certified pediatric urologist (CSC), *a priori* defined the likely risk window in days based on pathogenesis (eTable 1). The possible AE were further classified by CSC as potentially serious (italicized in eTable 1) or not, based on clinical judgment, and assuming a worst case scenario.

We edited the CDM MC dataset by a) removing circumcised males who had a MC date prior to their birth date, and b) reclassified newborn males who did not have a MC record but had a MC-specific AE (CPT: 54162 and 54163) as circumcised.

We performed a retrospective cohort study using log binomial regression modeling (SAS 9.2) to ascertain the risk associated with MC. We first calculated the incidence of each AE over its risk window, per million circumcised (and separately for uncircumcised) newborn

males using discharge date of circumcision (or birth for uncircumcised) for the beginning of the risk window. We then calculated the IRR, IRD, and their respective 95% confidence interval (CI) between the circumcised and uncircumcised groups. [24]

To minimize potential confusion on causal relationships in this exploratory study, the AE and person time outside the risk window in circumcised persons were deleted from analysis (instead of included in medical procedure-unexposed group as done in another risk window safety study).[25] An AE was considered *probably* related to MC if the IRR significantly exceeded one at $p<0.05$ or occurred only in circumcised newborn males. Multiple comparisons were not adjusted in our analysis because almost all the significant associations found were at $p<0.001$, which is less than any typically used correction factor (e.g., Bonferroni). To estimate the total incidence of AE associated with MC, we calculated the IRD between incidences of probable AE in circumcised vs. uncircumcised newborns, using unduplicated counts of males who had one or more AE in each group divided by the number of circumcised and uncircumcised newborns, respectively. For some syndromic groups, the risk window was not equal for all AE. To obtain the total for the syndromic group in this case, all conditions were followed for the longest risk window in the group. IRR and 95% CI were then generated.

We assessed if rates of probable MC AE differed in the following three age groups: males circumcised before one year of age (reference group), between one and nine years of age, and at age ten years or older. The age groups' cut-off points separated infants from children prior to puberty and older males. We used the same statistical approach as above to calculate incidence per million male circumcisions (PMMC), IRR, IRD, and 95% CI.

To better detect rare MC AE, we first conducted the analysis using all available data including CDM1, CDM2, and outpatient datasets. Due to CDM1 day of discharge being defaulted to the first day of the month, all AE risk windows <28 days were reset to 28 days, the shortest risk window that could possibly be tracked, and the closest to a complete month, in this analysis (Tables 2 and 3). We then conducted a second analysis maximizing specificity of date by using only CDM2 and outpatient, the two datasets with exact dates for each procedure needed for exact risk window analysis (eResults, eTable2, eTable 3. This research was determined to be exempt from institutional review board evaluation because it entailed secondary analysis of administrative data procured from SDI Health (http://sdihealth.com/portal/site/imshealth) without personal identifiable human subjects. SDI Health originally collected this data from processing of US health care insurance reimbursement claims.

Results

During 2001–2010, 1,400,920 MC reimbursement claims for males of all ages were submitted from U.S. hospital settings and available to SDIhealth (CDM1, CDM2, outpatient data). Forty seven males (0.0033%) had a MC dated prior to their birth date and these records were removed from analysis. Also, of all newborn males, 346 (0.015%) had a MC-specific AE but did not have a MC record. These were reclassified as circumcised newborn males.

Comparison of MC AE incidence between circumcised and uncircumcised newborn males (Table 2)

Data was available for a total of 2,339,760 newborn male births. Among these, 1,306,812 (55.8%) were linked to a circumcision record. Of the initial 41 possible MC AE, 16 (39%) met the criteria for probable MC AE (underlined in Table 2). Six probable MC AE occurred only in circumcised but not uncircumcised newborns [Amputation of penis, partial; Replantation of penis; Lysis or excision of penile post-circumcision adhesions; Repair incomplete circumcision; Stricture of male genital organ; and Suture of artery]. Among the 16 probable AE, ten were also classified as potentially serious.

There were 4,924 newborns, 4,059 circumcised and 865 uncircumcised, with one or more probable AE. In total, there were 5,385 and 1,100 AE recorded among circumcised and uncircumcised newborns, respectively. Of the 4,924 total, 4,523 (91.8%) were cared for in a hospital setting and 401 in outpatient setting. The estimated incidence of probable AE associated with MC was less than one percent, either crude [4.059/1,306,812 = 0.31% (95% CI = 0.30 – 0.32)] or adjusting for the background rate [(4,059/1,306,812) - (865/1,032,948) = 0.23% (95%CI = 0.21 – 0.24)].

The IRD for potential serious probable AE ranged from a low of 0.76 persons with Stricture of male genital organ PMMC (95%CI: 0.10 – 5.43) to a high of 703.23 persons with repair of incomplete circumcision PMMC (95%CI: 659.22 – 750.18). The most common probable MC AE was Division of penile adhesions [199.69 PMMC (95%CI: 153.92 – 245.66)].

Nine AE were significantly less likely to occur in circumcised compared to uncircumcised infants at $p<0.05$.

Circumcised newborn males had a higher risk for Wounds, Correctional procedures, Inflammations, and Bleedings compared to uncircumcised ones, but a lower risk for Surgical procedures, Penile disorders and gangrene, Pneumothorax and Infections.

Among the extremely rare but serious AE occurring only among circumcised newborns (but once or none among uncircumcised), we found no cases of Complete amputation of penis, three cases of Partial amputation of penis four cases of Replantation of penis,16 cases of Suture of artery, and one case of Stricture of male genital organs.

Comparison of MC AE by age group (Table 3)

Of the 1,400,920 circumcised males, 1,335,180 (95.3%) male infants were circumcised during infancy. Another 28,197 (2.0%) males were circumcised between age one and nine years, and 37,543 (2.7%) males were circumcised at age ≥10 years [8590 (22.9%) of whom were 10 – 18 years old]. Incidence of probable AE varied by age group: 0.40% (95% CI 0.39 – 0.41) among males circumcised during infancy; 9.06% (95% CI 8.73 – 9.40) among males circumcised between age one and nine years, and 5.31% (95% CI 5.09 – 5.55) among males circumcised at age ≥ten years; or approximately 20- and 10-fold higher for the older age groups compared to infants, respectively.

Except for the comparisons in which no AE cases occurred in one or both of the older age groups, the IRR of each of the other studied AE comparisons significantly exceeded one and IRD exceeded 100 PMMC (except for Suture of artery) when MC was performed after the first year of life. The highest IRR among males circumcised between one and nine years of age was found for Division of penile adhesions (IRR = 67.64; 95% CI: = 61.98 – 73.81). The highest IRR among males circumcised at age ≥ 10 years was found for Other inflammatory disorders of penis (IRR = 112.06; 95% CI: = 93.88 – 133.75). While these are not explicitly defied in the ICD-9 manual, they can be skin condition such as infection, cellulitis, abscess, boil, carbuncle, or cavernitis.

Discussion

We studied the AE outcomes after ~1.4 million MC in the United States, about 10 fold larger than the largest prior studies.[9–10] Using a broad definition of 41 possible MC AE to search a large medical administrative database, then restricting to the 16 probable MC AE with significantly elevated rates in pre-defined risk windows or occurring only in circumcised persons, we estimate the incidence of AE associated with newborn male circumcision in medical settings adjusted for the background rate to be less than half percent (0.30% for the more specific CDM2 dataset). Overall, the most common probable MC AE were related to correctional procedures at ~2000 PMMC and bleeding at ~1000 PMMC. Our findings were largely similar irrespective of whether the month-specific or date-specific datasets were used and consistent with the earlier U.S. studies given differences in methodology[9, 10].

Our findings also suggest that many AE such as penile reconstruction, pneumothorax and infections occur less frequently in circumcised males, perhaps due to a “healthy baby” bias – those newborns who undergo MC are more likely to be healthier (and without such disorders) compared to their uncircumcised counterparts. This type of selection bias is commonly seen in non-randomized observational studies of outcomes after medical procedures[26, 27] and results in the observed lower rate of AE among circumcised males.

We found the incidence of MC AE was 10 – 20-fold higher when performed at older age groups compared to infancy. These findings are consistent with earlier studies[22, 23] and may provide for the first time, a direct measure of the relative difference in AE rate by age at MC. Recent data on MC AE from a clinical trial in Kenya that included males 12 years of age or older, reported similar high rates of AE for this age group[28]. Interestingly, in a study on infant MC AE from Kenya, an increased risk for AE was found if MC was performed in the second month of life compared to the first one[29]. The indications for MC in older age groups in the U.S. may be more medical in nature (e.g., infections, adhesions) than the cultural/religious basis in most routine healthy newborns, however; future studies will need to carefully adjust for this potential source of confounding.

The incidence of amputations was highest among males circumcised at ten years of age or older: 0.17% (95% CI: 0.13 – 0.21%). In total, the absolute number of amputations in our database was 71. Most penile amputations captured in our dataset (45 out of 71) are recorded using ICD-9 code 643.0 which does not differentiate complete from partial penile

amputation. Of the 71 recorded amputations, three were coded as complete — one among males circumcised in infancy, and two among males circumcised at ten years of age or older. Wiswell reported the absence of total penile amputations over five years in a study of MC AE among newborns from U.S. Army hospital settings[9]. Consistent with these findings, our data captured less than one total penile amputation PMMC, suggesting the possibility that most penile amputations recorded using ICD-9 code and captured in our dataset are likely to be partial. Without access to primary medical records, we can only speculate that the four patients that had penile amputation in the uncircumcised population likely were miscoded, were circumcised at non-medical settings, or patients undergoing operative intervention for severe genital anomalies. It's noteworthy that other studies have reported on the success of treatment, including replantation, in the case of penile amputations.[30, 31] We could not study deaths potentially related to MC as deaths in general are not captured in healthcare reimbursement claims databases like SDIhealth. In an earlier review, Wiswell reported three deaths due to male circumcision during the period 1954 – 1989 [~0.08 deaths from neonatal MC in the United States per year].[9]

Our study has several potential limitations. First, most of our data (~80%) assigns a discharge date of the first day of the month for the medical record. Hence, in the case where the AE has a risk window of < 28 days and falls in the same month of the MC it will be counted even if it occurs outside of the risk window. Also, in the case where an AE has a risk window of < 28 days and is encountered during the month following MC, it will be missed. The first scenario tends to over count some AE while the second tends to undercount some others. However, limiting our analysis to data with exact discharge date, our findings remained almost unchanged (eResults, eTable 2, eTable 3). At the same time, some of the males circumcised within the last year of our data, might have encountered an AE within a risk window outside of the available data. This might have decreased our overall rate of AE by a small fraction. Secondly, if an AE occurred on the same day of MC, it is impossible to determine whether the AE occurred before or after MC. Indeed, certain AE can also be an indication for MC. Hence, our reported rate might be inflated in case some AE were diagnosed on the same day as, or before MC.

A third limitation is that our data may not be generalized to the entire U.S. population as it came from a convenience sample. However,, the very large volume of administrative SDIhealth data used in this study (~20% of U.S. hospital discharges and >870,000 unique outpatient medical providers) strengthens our findings. A recent publication showed the trends in neonatal MC in SDIhealth data were virtually identical to that of two nationally representative datasets[32] also further support its validity- at least for newborn males.

A fourth limitation of our data was that it was collected for billing purposes only. If a circumcision or an AE was not covered by a third party payer, it would be missing from this analysis. Also, some circumcisions might occur in non-medical settings, such as religious MC, but a resulting AE might require medical intervention, and hence be captured as occurring among uncircumcised newborns. Indeed, some uncircumcised newborn males in our data had a MC-specific AE. However, these did not exceed 0.01% of all newborns and the incidence of AE in our analysis was in the range of those from previous U. S.

publications. [9–10] Therefore, while the true rate may be lower or higher than our estimates, billing records should capture the vast majority of MC procedures.

Finally, MC can occur concurrently with other operative procedures for anesthesia-convenience reasons. The AE that might result from these cases might be confounded by other health conditions of the patient. Future studies overcoming these limitations and examining other databases to confirm our findings are needed to better estimate specific AE rates attributable only to MC.

Conclusions

Our data suggest the rate of AE associated with newborn circumcision is less than half percent. Importantly, the incidence of AE increased substantially when MC occurred after the first year of life. Given the current debate about whether MC should be delayed from infancy to adulthood for autonomy reasons[33], our results are timely and can help physicians counsel parents about circumcising their sons.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. American Academy of Pediatrics Taks Force on Circumcision. Circumcision policy statement. Pediatrics. 2012; 130(3):585–586. [PubMed: 22926180]
2. Bailey RC, Moses S, Parker CB, et al. Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomised controlled trial. Lancet. 2007; 369(9562):643–656. [PubMed: 17321310]
3. Auvert B, Taljaard D, Lagarde E, et al. Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: the ANRS 1265 Trial. PLoS Med. 2005; 2(11):e298. [PubMed: 16231970]
4. Gray RH, Kigozi G, Serwadda D, et al. Male circumcision for HIV prevention in men in Rakai, Uganda: a randomised trial. Lancet. 2007; 369(9562):657–666. [PubMed: 17321311]
5. Smith DK, Taylor A, Kilmarx PH, et al. Male circumcision in the United States for the prevention of HIV infection and other adverse health outcomes: report from a CDC consultation. Public Health Rep. 2010; 25(Suppl 1):72–82. [PubMed: 20408390]

6. Bristol N. Male circumcision debate flares in the USA. Lancet. 2011; 3781837(9806):5–26. [PubMed: 21703675]
7. Collier R. Ugly, messy and nasty debate surrounds circumcision. CMAJ. 2012; 184(1):E2.
8. Nadeau, BL. [Accessed on 09/27/2012] Europe goes after circumcision. A sacred religious ritual or a criminal act? New charges against an Israeli rabbi living in Germany have flared the foreskin debate across the continent. The Daily Beast. 2012 Aug 24. Available at: http://www.thedailybeast.com/articles/2012/08/24/europe-goes-after-circumcision.html
9. Wiswell TE, Geschke DW. Risks from circumcision during the first month of life compared with those for uncircumcised boys. Pediatrics. 1989; 83(6):1011–1015. [PubMed: 2562792]
10. Christakis DA, Harvey E, Zerr DM, Zerr DM, Feudtner C, Wright JA, Connell FA. A trade-off analysis of routine newborn circumcision. Pediatrics. 2000; 105(1 pt 3):246–249. [PubMed: 10617731]
11. Ozkan S, Gurpinar T. A serious circumcision complication: penile shaft amputation and a new reattachment technique with a successful outcome. J Urol. 1997; 158(5):1946–1947. [PubMed: 9334645]
12. Atikeler MK, Geçit I, Yüzgeç V, Yalçin O. Complications of circumcision performed within and outside the hospital. Int Urol Nephrol. 2005; 37(1):97–99. [PubMed: 16132769]
13. Ben Chaim J, Livne PM, Binyamini J, Hardak B, Ben-Meir D, Mor Y. Complications of circumcision in Israel: a one year multicenter survey. Isr Med Assoc J. 2005; 7(6):368–370. [PubMed: 15984378]
14. Corbett H, Humphrey G. Early complications of circumcisions performed in the community. Br J Gen Pract. 2003; 53(496):887–888. [PubMed: 14702913]
15. Van Howe RS. Incidence of meatal stenosis following neonatal circumcision in a primary care setting. Clin Pediatr (Phila). 2006; 45(1):49–54. [PubMed: 16429216]
16. Pieretti RV, Goldstein AM, Pieretti-Vanmarcke R. Late complications of newborn circumcision: a common and avoidable problem. Pediatr Surg Int. 2010; 26(5):515–518. [PubMed: 20155423]
17. Ozdemir E. Significantly increased complication risks with mass circumcisions. Br J Urol. 1997; 80(1):136–139. [PubMed: 9240193]
18. Kigozi G, Gray RH, Wawer MJ, et al. The safety of adult male circumcision in HIV-infected and uninfected men in Rakai, Uganda. PLoS Med. 2008; 5(6):e116. [PubMed: 18532873]
19. Kiggundu V, Watya S, Kigozi G, et al. The number of procedures required to achieve optimal competency with male circumcision: findings from a randomized trial in Rakai, Uganda. BJU Int. 2009; 104(4):529–532. [PubMed: 19389002]
20. Wilcken A, Keil T, Dick B. Traditional male circumcision in eastern and southern Africa: a systematic review of prevalence and complications. Bull World Health Organ. 2010; 88(12):907–914. [PubMed: 21124715]
21. Mousavi SA, Salehifar E. Circumcision complications associated with the Plastibell device and conventional dissection surgery: a trial of 586 infants of ages up to 12 months. Adv Urol. 2008:606123. [PubMed: 19009030]
22. Weiss HA, Larke N, Halperin D, Schenker I. Complications of circumcision in male neonates, infants and children: a systematic review. BMC Urol. 2010; 10:2. [PubMed: 20158883]
23. Horowitz M, Gershbein AB. Gomco circumcision: when is it safe? J Pediatr Surg. 2001; 36(7): 1047–1049. [PubMed: 11431774]
24. Fleiss, JL. Statistical methods for rates and proportions. New York, NY: John Wiley & Sons; 1981.
25. Glanz JM, McClure DL, Xu S, et al. Four different study designs to evaluate vaccine safety were equally validated with contrasting limitations. J Clin Epidemiol. 2006; 59(8):808–818. [PubMed: 16828674]
26. Fine PE, Chen RT. Confounding in studies of adverse reactions to vaccines. Am J Epidemiol. 1992; 136(2):121–135. [PubMed: 1415136]
27. France EK, Glanz JM, Xu S, Davis RL, Black SB, Shinefield HR, Zangwill KM, Marcy SM, Mullooly JP, Jackson LA, Chen R. Safety of the trivalent inactivated influenza vaccine among children: a population-based study. Arch Pediatr Adolesc Med. 2004; 158:1031–1036. [PubMed: 15520339]

28. Herman-Roloff A, Bailey RC, Agot K. Factors associated with the safety of voluntary medical male circumcision in Nyanza Province, Kenya. Bull World Health Organ. 2012; 90(10):773–781. [PubMed: 23109745]

29. Young MR, Bailey RC, Odoyo-June E, et al. Safety of over twelve hundred infant male circumcisions using the Mogen clamp in Kenya. PLoS One. 2012; 7(10):247395.

30. Gluckman GR, Stoller ML, Jacobs MM, Kogan BA. Newborn penile glans amputation during circumcision and successful reattachment. J Urol. 1995; 153(3 pt 1):778–779. [PubMed: 7861536]

31. Jezior JR, Brady JD, Schlossberg SM. Management of penile amputation injuries. World J Surg. 2001; 25(12):1602–1609. [PubMed: 11775199]

32. Centers for Disease Control and Prevention (CDC). Trends in in-hospital newborn male circumcision—United States, 1999–2010. MMWR Morb Mortal Wkly Rep. 2011; 60(34):1167–1168. [PubMed: 21881548]

33. Benatar M, Benatar D. Between prophylaxis and child abuse: the ethics of neonatal male circumcision. Am J Bioeth. 2003; 3(2):35–48. [PubMed: 12859815]

Table 1

Counts, incidence rates, incidence risk ratio, and incidence rate difference of adverse events between circumcised and uncircumcised newborn males. Charge Data Master 1 (CDM1), CDM2, and outpatient data, Unites States 2001 – 2010

Adverse events[a] (*Italicized* = *Potentially serious*; Underlined = probably associated with male circumcision)	**Count among uncircumcised newborns (Incidence per million uncircumcised newborn; 95% CI) N = 1,032,948**	**Count among circumcised newborns (Incidence per million circumcised newborn; 95% CI) N = 1,306,812**	**P value**	**Incidence Risk Ratio (95% CI)**	**Incidence Rate Difference (95% CI)**
Amputations[b]	4 (3.87; 1.45 – 10.31)	3 (2.29; 0.74 – 7.11)	0.5	0.59 (0.13 – 2.64)	−1.58(−6.18 – 3.02)
Amputation of penis[b]	4 (3.87; 1.45 – 10.31)	0 (0)	N.A.	N.A.	N.A.
Amputation of penis, partial[b]	0 (0)	3 (2.29; 0.74 – 7.11)	N.A.	N.A.	3 (2.29; 0.74 – 7.11)
Wounds[b]	32 (30.97; 21.90 – 43.80)	89 (68.10; 55.32 – 83.83)	<0.001	2.19 (1.46 – 3.29)	37.12(19.37 – 54.88)
Open wound of penis without mention of complication[b]	29 (28.07; 19.51 – 40.40)	83 (63.51; 51.21 – 78.75)	<0.001	2.26 (1.48 – 3.45)	35.44(18.38 – 52.50)
Open wound of penis, complicated[b]	3 (2.90; 0.93 – 9.00)	6 (4.59; 2.06 – 10.21)	0.5	1.58 (0.39 – 6.32)	1.68(−3.24 – 6.62)
Correctional procedures[e]	644 (623.45; 577.13 – 673.50)	3281 (2510.69; 2426.33 – 2597.97)	<0.001	4.02 (3.70 – 4.38)	1887.23(1778.85 – 1985.62)
Suture of laceration of penis[b]	43 (41.62; 30.87 – 56.12)	293 (224.21; 199.95 – 251.40)	<0.001	5.38 (3.91 – 7.41)	182.58(154.06 – 211.11)
Suture of laceration of penis[e]	55 (53.24; 40.88 – 69.35)	299 (228.80; 204.28 – 256.25)	<0.001	4.29 (3.22 – 5.72)	175.56(146.05 – 205.06)
Reconstruction of penis[d]	64 (61.95; 48.49 – 79.15)	15 (11.47; 6.91 – 19.03)	<0.001	0.18 (0.10 – 0.32)	−50.48(−66.03 – −34.23)
Reconstruction of penis[e]	77 (74.54; 59.62 – 93.19)	30 (22.95; 16.05 – 32.83)	<0.001	0.30 (0.20 – 0.46)	−51.59(−70.15 – −23.02)
Replantation of penis[b]	0 (0)	4 (3.06; 1.14 – 8.15)	N.A.		
Replantation of penis[e]	1 (0.96; −0.13 – 6.87)	4 (3.06; 1.14 – 8.15)	0.3	3.16 (0.35 – 28.28)	2.09(−1.46 – 5.64)
Other repairs of penis[d]	181 (175.22; 151.47 – 202.70)	354 (270.88; 244.09 – 300.62)	<0.001	1.54 (1.29 – 1.84)	95.66(57.61 – 133.71)
Other repairs of penis[e]	277 (268.16; 238.37 – 301.67)	715 (547.13; 508.47 – 588.73)	<0.001	2.04 (1.77 – 2.34)	278.97(227.93 – 330.00)
Division of penile adhesions[e]	234 (226.53; 199.29 – 257.49)	557 (426.22; 392.26 – 463.12)	<0.001	1.88 (1.61 – 2.19)	199.69(153.92 – 245.66)
Lysis or excision of penile post-circumcision adhesions[e]	0 (0)	757 (579.27; 539.45 – 622.02)	N.A.	N.A.	757 (579.27; 539.45 – 622.02)
Repair incomplete circumcision[e]	0 (0)	919 (703.23; 659.22 – 750.18)	N.A.	N.A.	919 (703.23; 659.22 – 750.18)
Surgical procedures[e]	224 (216.85; 190.24 – 247.19)	52 (39.79; 30.32 – 52.21)	<0.001	0.18 (0.13 – 0.240	−177.06(−207.65 – −146.68)

Adverse events[a] (*Italicized* = *Potentially serious*; Underlined = probably associated with male circumcision)	**Count among uncircumcised newborns (Incidence per million uncircumcised newborn; 95% CI) N = 1,032,948**	**Count among circumcised newborns (Incidence per million circumcised newborn; 95% CI) N = 1,306,812**	**P value**	**Incidence Risk Ratio (95% CI)**	**Incidence Rate Difference (95% CI)**
Incision of penis[b]	186 (180.06; 155.96 – 207.89)	21 (16.07; 10.47 – 24.64)	<0.001	0.08 (0.05 – 0.14)	−163.99(−190.77 – −137.22)
Incision of penis[e]	202 (195.55; 170.36 – 224.46)	35 (26.78; 19.22 – 37.30)	<0.001	0.13 (0.09 – 0.19)	−168.77(−197.16 – −140.39)
Other operations on penis[e]	22 (21.29; 14.02 – 32.34)	17 (13.00; 8.08 – 20.92)	0.1	0.61 (0.32 – 1.15)	−8.29(−19.13 – 2.54)
Disorders[b]	1062 (1028.12; 968.14 – 1091.82)	799 (611.41; 570.46 – 655.29)	<0.001	0.59 (0.54 – 0.65)	−416.71(−491.65 – −341.77)
Vascular disorders of penis[b]	11 (10.64; 5.89 – 19.22)	70 (53.56; 42.37 – 67.70)	<0.001	5.03 (2.66 – 9.49)	42.92(28.88 – 56.95)
Other specified disorders of penis[b]	934 (904.20; 849.06 – 964.06)	638 (488.21; 451.76 – 527.59)	<0.001	0.59 (0.53 – 0.65)	−415.99(−485.24 – −346.76)
Unspecified disorders of penis[b]	87 (84.224; 68.26 – 103.91)	78 (59.68; 47.80 – 74.51)	0.02	0.70 (0.52 – 0.96)	−24.54(−46.64 – 2.43)
Gangrene, death and decay of body tissue, often occurring in a limb, caused by insufficient blood supply and usually following injury or disease[b]	30 (29.04; 20.30 – 41.53)	13 (9.94; 5.77 – 17.13)	0.001	0.34 (0.17 – 0.65)	−19.09(−30.81 – −7.38)
Pneumothorax[b]	263 (254.61; 225.62 – 287.31)	120 (91.82; 76.78 – 109.81)	<0.001	0.36 (0.29 – 0.44)	−162.78(−197.66 – −127.91)
Spontaneous tension pneumothorax[b]	144 (139.40; 118.40 – 164.13)	66 (50.50; 39.67 – 64.28)	<0.001	0.36 (0.27 – 0.48)	−88.90(−114.73 – −63.08)
Iatrogenic pneumothorax[b]	119 (115.20; 96.25 – 137.87)	54 (41.32; 31.64 – 53.95)	<0.001	0.35 (0.26 – 0.49)	−73.88(−97.33 – 50.43)
Infections[b]	842 (815.14; 761.92 – 872.07)	834 (638.19; 596.33 – 682.99)	<0.001	0.78 (0.71 – 0.86)	−176.95(−246.98 – −106.92)
Meningitis of unspecified cause: non-pyogenic meningitis[b]	2 (1.93; 0.48 – 7.74)	2 (1.53; 0.38 – 6.11)	0.99	0.79 (0.11 – 5.61)	−0.41(−3.82 – 3.01)
Meningitis of unspecified cause: meningitis unspecified[b]	415 (401.76; 364.91 – 442.32)	399 (305.32; 276.79 – 336.79)	<0.001	0.76 (0.66 – 0.87)	−96.44(−145.34 – −47.54)
Methicillin resistant pneumonia due to staphylococcus aureus[b]	9 (8.71; 4.53 – 16.74)	5 (3.82; 1.59 – 9.19)	0.1	0.43 (0.14 – 1.31)	−4.98(−11.49 – 1.72)
Cellulites, unspecified site[b]	160 (154.89; 132.66 – 180.85)	207 (158.40; 138.22 – 181.51)	0.8	1.02 (0.83 – 1.25)	3.50(−28.77 – 35.78)
Bacteremia[b]	252 (243.96; 215.62 – 276.01)	203 (155.34; 135.37 – 178.24)	<0.001	0.63 (0.52 – 0.76)	−88.62(−125.55 – −51.69)
Staphylococcal scalded skin syndrome/Ritter's disease[b]	4 (3.87; 1.45 – 10.31)	18 (13.77; 8.67 – 21.86)	0.02	3.55 (1.20 – 10.50)	9.90(2.49 – 17.31)
Inflammations[b]	313 (303.01; 271.24 – 338.50)	616 (471.37; 435.59 – 510.10)	<0.001	1.55 (1.35 – 1.78)	168.36(118.24 – 218.47)
Other inflammatory disorders of penis/Cellulites penis[b]	42 (40.66; 30.04 – 55.01)	142 (108.66; 99.21 – 136.35)	<0.001	2.67 (1.89 – 3.77)	68.00(46.31 – 89.69)

Adverse events[a] (*Italicized* = *Potentially serious*; Underlined = probably associated with male circumcision)	**Count among uncircumcised newborns (Incidence per million uncircumcised newborn; 95% CI) N = 1,032,948**	**Count among circumcised newborns (Incidence per million circumcised newborn; 95% CI) N = 1,306,812**	**P value**	**Incidence Risk Ratio (95% CI)**	**Incidence Rate Difference (95% CI)**
Edema of penis[b]	108 (104.55; 86.58 – 126.25)	289 (221.14; 197.06 – 248.17)	<0.001	2.11 (1.69 – 2.63)	116.59(84.36 – 148.82)
Other inflammatory disorders of male genitals[b]	17 (16.45; 10.23 – 26.47)	35 (26.78; 19.22 – 37.30)	0.09	1.62 (0.91 – 2.90)	10.33(−1.0 – 22.15)
Edema of male genital organs[b]	146 (141.34; 120.18 – 166.23)	150 (114.78; 97.80 – 134.70)	0.07	0.81 (0.64 – 1.01)	−26.56(−55.94 – 2.82)
Strictures[c]	73 (70.67; 56.18 – 88.89)	104 (79.58; 65.66 – 96.44)	0.4	1.12 (0.83 – 1.51)	8.91(−13.37 – 31.19)
Postoperative urethral stricture[c]	1 (0.96; −0.13 – 6.87)	8 (6.12; 3.06 – 12.24)	0.08	6.32 (0.79 – 50.55)	5.15(0.51 – 9.80)
Urethral stricture, unspecified[c]	72 (69.70; 55.32 – 87.81)	95 (72.69; 59.45 – 88.88)	0.78	1.04 (0.76 – 1.41)	2.99(−18.75 – 24.74)
Stricture of male genital organs[c]	0 (0)	1 (0.76; 0.10 – 5.43)	N.A.		0.76 (0.10 – 5.43)
Bleeding[b]	462 (447.26; 408.29 – 489.95)	1889 (1445.50; 1381.80 – 1512.13)	<0.001	3.23 (2.91 – 3.57)	998.24(921.39 – 1075.09)
Unspecified hemorrhage of newborn[b]	44 (42.59; 31.69 – 57.23)	37 (28.31; 20.51 – 39.07)	0.06	0.66 (0.42 – 1.02)	−14.28(−29.82 – 1.26)
Intra-operative bleeding[b]	350 (338.83; 305.13 – 376.25)	1614 (1235.06; 1176.29 – 1296.77)	<0.001	3.73 (3.31 – 4.19)	896.23(826.33 – 966.13)
Hemorrhage control[b]	26 (25.17; 17.13 – 36.96)	173 (132.38; 114.05 – 153.65)	<0.001	5.25 (3.48 – 7.94)	107.21(85.24 – 129.18)
Suture of artery[b]	0 (0)	16 (12.24; 7.50 – 19.98)	N.A.		12.24 (7.50 – 19.98)
Suture of vein[b]	32 (30.97; 21.90 – 43.80)	30 (22.95; 16.05 – 32.83)	0.2	0.74 (0.45 – 1.21)	−8.02(−21.59 – 5.94)
Suture of vessel[b]	10 (9.68; 5.20 – 17.99)	19 (14.53; 9.27 – 22.79)	0.29	1.50 (0.69 – 3.22)	4.86(−4.01 – 13.73)

[a] The total count for a group of adverse events was obtained by adding counts of all individual; *potentially serious AE are Italicized*

[b] Risk window defined for 28 days post-circumcision or post-birth for circumcised males and uncircumcised males respectively

[c] Risk window defined for 180 days post-circumcision or post-birth for circumcised males and uncircumcised males respectively

[d] Risk window defined for 365 days post-circumcision or post-birth for circumcised males and uncircumcised males respectively

[e] Risk window defined for 1200 days post-circumcision or post-birth for circumcised males and uncircumcised males respectively

Note: Adverse events that were not encountered in this analysis, i.e. had a count of zero, were not presented to reduce the length of the table. These are: complete amputation of penis, repair and plastic operation on penis, incision and drainage of penis.

CI: confidence interval

N.A.: not applicable

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Table 2

Counts, incidence rates and incidence risk ratio of adverse events between males circumcised at 3 different age groups. Charge Data Master 1 (CDM1), CDM2, and outpatient data, Unites States 2001 – 2010

Adverse events (*Italicized* = *Potentially serious*)	**Age at circumcision**	**Count among circumcised males (Incidence per million circumcisions; 95% CI)**	**Incidence Risk Ratios (95% CI)**	**Incidence Rate Difference (95% CI)**
Amputations[a]	< 1 year old	8(5.99;3.00–11.99)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	63(1678.07; 1311.17 – 2147.64)	81.29(33.44 – 197.58)	420.94(212.12 – 629.75)
Amputation of penis[a]	< 1 year old	0 (0)	Reference group	Reference group
	1 – 9 years old	0 (0)	N.A.	N.A.
	≥ 10 years old	45 (1198.62; 895.09 – 1605.08)	N.A.	45 (1198.62; 895.09 – 1605.08)
Amputation of penis, partial[a]	< 1 year old	7(5.24;2.50 – 11.00)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	16(426.18; 261.12 – 695.58)	81.29(33.44 – 197.58)	420.94(212.12 – 629.75)
Amputation of penis, complete[a]	< 1 year old	1 (0.75; 2.50 – 11.01)	Reference group	Reference group
	1 – 9 years old	0 (0)	N.A.	N.A.
	≥ 10 years old	2 (53.27; 26.11 – 69.55)	71.03 (6.44 – 783.35)	52.52(−21.32–126.37)
Wounds[a]	< 1 year old	87 (65.25; 52.88 – 80.50)	Reference group	Reference group
	1 – 9 years old	11 (390.11; 216.06 – 704.34)	5.97 (3.19 – 11.19))	324.95(94.05 – 555.86)
	≥ 10 years old	113 (3009.88; 2503.77 – 3618.28)	46.12 (34.88 – 60.99))	2944.7(2390.4 – 3499.0)
Open wound of penis w/out mention of complications[a]	< 1 year old	87 (65.25; 52.88 – 80.50)	Reference group	Reference group
	1 – 9 years old	11 (390.11; 216.06 – 704.34)	5.97 (3.19 – 11.19)	324.95(94.05 – 555.86)
	≥ 10 years old	113 (3009.88; 2503.77 – 3618.28)	46.12 (34.88 – 60.99)	2944.7(2390.4 – 3499.0)
Correctional procedures[d]	< 1 year old	4018(3009.3;2917.8 – 3103.7)	Reference group	Reference group
	1 – 9 years old	2947 (104515;101004 – 108147)	34.73(33.17 – 36.37)	101505(97933 – 105077)
	≥ 10 years old	1219 (32469;30725 – 34313)	10.79(10.13 – 11.49)	29460(27665 – 31255)
Suture of laceration of penis[a]	< 1 year old	314 (235.49; 210.84 – 263.03)	Reference group	Reference group
	1 – 9 years old	25 (886.61; 599.20 – 1311.90)	3.76 (2.50 – 5.65)	651.44(303.07 – 999.82)

Adverse events (*Italicized* = *Potentially serious*)	**Age at circumcision**	**Count among circumcised males (Incidence per million circumcisions; 95% CI)**	**Incidence Risk Ratios (95% CI)**	**Incidence Rate Difference (95% CI)**
	≥ 10 years old	55 (1464.98; 1124.97 – 1907.76)	6.22 (4.67 – 8.28)	1229.8(842.05 – 1617.6)
Suture of laceration of penis[d]	< 1 year old	322 (241.49; 216.51 – 269.36)	Reference group	Reference group
	1 – 9 years old	27 (957.74; 656.78 – 1396.03)	3.96 (2.67 – 5.870	716.38(354.41 – 1078.4)
	≥ 10 years old	61 (1624.80; 1264.45 – 2087.84)	6.72 (5.11 – 8.84)	1383.6(975.37 – 1791.9)
Replantation of penis[a]	< 1 year old	4(3.00;1.12 – 7.98)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	0	N.A.	N.A.
Replantation of penis[d]	< 1 year old	4(3.00;1.12 – 7.98)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	0	N.A.	N.A.
Other repair of penis[c]	< 1 year old	841 (630.74; 589.53 – 674.83)	Reference group	Reference group
	1 – 9 years old	468 (16598.00; 15171.34 – 18157.74)	26.31 (23.51 – 29.44)	15968(14476 – 17459)
	≥ 10 years old	394 (10495.00; 9512.83 – 11577.76)	16.63 (14.76 – 18.74)	9864.8(8833.1 – 10896)
Other repair of penis[d]	< 1 year old	1213 (909.74; 859.98 – 962.38)	Reference group	Reference group
	1 – 9 years old	471 (16704.00; 15273.04 – 18268.81)	18.36 (16.51 – 20.40)	15795(14299 – 17292)
	≥ 10 years old	399 (16628; 9639.56 – 11717.37)	11.68 (10.43 – 13.07)	9719.3(8680.8 – 10758)
Division of penile adhesions[d]	< 1 year old	841 (630.74; 589.53 – 674.83)	Reference group	Reference group
	1 – 9 years old	1203 (42664.00; 40369.23 – 45089.44)	67.64 (61.98 – 73.81)	42034(39675 – 44394)
	≥ 10 years old	489 (13025.00; 11927.20 – 14223.97)	20.65 (18.48 – 23.07)	12395(11247 – 13543)
Lysis or excision of penile post-circumcision adhesions[d]	< 1 year old	685 (513.74; 476.68 – 553.68)	Reference group	Reference group
	1 – 9 years old	369 (13086.00; 11825.03 – 14482.52)	25.47 (22.45 – 28.89)	12573(11246 – 13901)
	≥ 10 years old	116 (3089.79; 2576.43 – 3705.43)	6.01 (4.94 – 7.32)	2576.8(2014.0 – 3139.5)
Repair incomplete circumcision[d]	< 1 year old	953 (714.74; 670.79 – 761.57)	Reference group	Reference group
	1 – 9 years old	877 (31103.00; 29140.98 – 33196.26)	43.51 (39.73 – 47.65)	30389(28362 – 32416)
	≥ 10 years old	154 (4101.96; 3503.81 – 4802.22)	5.73 (4.84 – 6.80)	3388.2(2740.1 – 4036.3)
Disorders[a]	< 1 year old	17 (12.73; 7.92 –20.48)	Reference group	Reference group

Adverse events (*Italicized* = *Potentially serious*)	**Age at circumcision**	**Count among circumcised males (Incidence per million circumcisions; 95% CI)**	**Incidence Risk Ratios (95% CI)**	**Incidence Rate Difference (95% CI)**
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	9 (239.73; 124.74 – 460.70)	18.83 (8.39 – 42.24)	226.99 (70.27 – 383.71)
Vascular disorders of Penis[a]	< 1 year old	17 (12.73; 7.92 –20.48)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	9 (239.73; 124.74 – 460.70)	18.83 (8.39 – 42.24)	226.99 (70.27 – 383.71)
Infections[a]	< 1 year old	18 (13.48; 8.49 –21.40)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	0	N.A.	N.A.
Staphylococcal scalded skin syndrome / Ritter's disease[a]	< 1 year old	18 (13.48; 8.49 –21.40)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	0	N.A.	N.A.
Inflammations[a]	< 1 year old	470 (352.01;321.59 – 385.31)	Reference group	Reference group
	1 – 9 years old	191 (6773.77;5880.97 – 7802.11)	16.45 (13.93 – 19.43)	6421.8(5463.8 – 7379.7)
	≥ 10 years old	673 (17926.11;16632.98 – 19319.78)	83.05 (74.11 – 93.07)	17574(16232 – 18917)
Other inflammatory disorders of penis / cellulites penis[a]	< 1 year old	161 (120.74; 103.46 – 140.91)	Reference group	Reference group
	1 – 9 years old	111 (3936.58; 3269.54 – 4739.72)	32.60 (25.60 – 41.50)	3816.0(3084.9 – 4547.1)
	≥ 10 years old	508 (13531.00; 12411.52 – 14751.77)	112.06 (93.88 – 133.75)	13411(12242 – 14579)
Edema of penis[a]	< 1 year old	309 (231.74; 207.29 – 259.07)	Reference group	Reference group
	1 – 9 years old	80 (2837.18; 2279.58 – 3531.17)	12.24 (9.57 – 15.65)	2605.8(1984.4 – 3227.1)
	≥ 10 years old	165 (4394.96; 3774.28 – 5117.70)	18.96 (15.70 – 22.90)	4163.5(3493.9 – 4833.2)
Strictures[b]	< 1 year old	1(0.75;0.11 – 5.32)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	1(26.64;3.75 – 189.09)	35.56(2.22 – 568.60)	25.89(−26.34 – 78.11)
Stricture of male genital organs[b]	< 1 year old	1(0.75;0.11 – 5.32)	Reference group	Reference group
	1 – 9 years old	0	N.A.	N.A.
	≥ 10 years old	1(26.64;3.75 – 189.09)	35.56(2.22–568.60)	25.89(−26.34 – 78.11)

Adverse events (*Italicized = Potentially serious*)	**Age at circumcision**	**Count among circumcised males (Incidence per million circumcisions; 95% CI)**	**Incidence Risk Ratios (95% CI)**	**Incidence Rate Difference (95% CI)**
Bleeding[a]	< 1 year old	1998(1496.4;1432.3 – 1563.5)	Reference group	Reference group
	1 – 9 years old	279(9894.7;8804.3 – 11120)	6.61(5.84 – 7.49)	8398.2(7241.1 – 9555.4)
	≥ 10 years old	332(8843.2; 7945.1 – 9842.8)	5.91(5.26 – 6.63)	7346.8(6397.5 – 8296.1)
Intra-operative bleeding[a]	< 1 year old	1779 (1334.23; 1273.69 – 1397.65)	Reference group	Reference group
	1 – 9 years old	249 (8830.72; 7803.55 – 9993.10)	6.61 (5.80 – 7.55)	7498.3(6404.6 – 8592.1)
	≥ 10 years old	304 (8097.38; 7239.73 – 9056.62)	6.06 (5.37 – 6.85)	6765.0(5856.3 – 7673.7)
Hemorrhage control[a]	< 1 year old	200 (149.99; 130.58 – 172.29)	Reference group	Reference group
	1 – 9 years old	27 (957.54; 656.78 – 1396.03)	6.38 (4.27 – 9.53)	807.76(446.14 – 1169.4)
	≥ 10 years old	27 (719.17; 714.17 – 1360.00)	4.79 (3.20 – 7.16)	569.38(297.41 – 841.35)
Suture of artery[a]	< 1 year old	19(14.23; 9.08 – 22.31)	Reference group	Reference group
	1 – 9 years old	3(106.39;34.32 – 329.86)	7.48(2.21 – 25.26)	92.16(−28.40 – 212.72)
	≥ 10 years old	1(26.64;3.75 – 189.09)	1.87(0.25 – 13.98)	12.41(−40.19 – 65.00)

[a]Risk window defined for 28 days post-circumcision

[b]Risk window defined for 180 days post-circumcision

[c]Risk window defined for 365 days post-circumcision

[d]Risk window defined for 1200 days post-circumcision

Note: Adverse events that were not encountered in this analysis, i.e. had a count of zero, were not presented to reduce the length of the table. These are: repair and plastic operation on penis.

CI: confidence interval

N.A.: not applicable