Original Article

Water contamination and the rate of infections for water births

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ABSTRACT

Objective:
The potential for increased risks of infection is an important concern with water births. We performed microbiological analyses on water samples taken from birthing pools before and after water births, and compared the rate of neonatal infection arising after water births with that arising after conventional delivery.

Materials and Methods:
In this prospective observational study beginning in 2001, water from the delivery pool was analyzed to determine the prevailing micro-organisms. Two water samples were taken at each delivery. The first sample (sample A) was taken after the tub was filled with tap water; the second sample (sample B) was taken after the delivery. The high rate of water contamination with Legionella pneumophila and Pseudomonas aeruginosa induced us to install a filter system (Aquasafe –Filter®) into the supply hose for the birthing pool to reduce the water contamination. This intervention significantly reduced the total microbial loading and there was no longer evidence of Legionella pneumophila.

Furthermore we determined the rate of neonatal infections in infants delivered in water and compared it with those delivered conventionally out of the water.

Results:
Samples were obtained from 300 out of a total of 1407 water deliveries which took place between 2001 and 2006.

Before the installation of a filter system, 29% of the A samples showed bacterial growth with Legionella pneumophila, 22% with Pseudomonas aeruginosa, 18% with enterococci, 32% with coliforms, and 8% with Escherichia coli.

After the installation of the filter system, the water contamination decreased considerably:
- there were no further signs of Legionella bacteria, and Pseudomonas aeruginosa was found in only 3% and coliforms in 13% of the samples, respectively.

By comparing the microbiological composition of the B-samples before and after installation of the filter system, we concluded that the intervention did not influence the microbial loading of the
water, which occurred during and as a result of the whole delivery phase. The microbiological loading of the water in the birthing pool after it was filled may have partly originated from the insufficient cleaning and disinfection of the birthing pool and after changing the cleaning records there was no longer any evidence of a significant microbial count (unpublished data).

Of the B samples 82% contained large amounts of coliforms, 64% contained Escherichia coli with concentrations of up to 105 CFU/100 mL, and 8-12% contained Pseudomonas aeruginosa. Staphylococcus aureus and Candida spp were also present in moderate amounts.

The rate of neonates treated with antibiotics for suspected infection on the basis of clinical symptoms (tachypnoea, skin color) or laboratory findings (CRP rise, leukocytosis) was 1.13% after water births (16 out of 1407) compared with 2.03% (20 out of 982) after conventional delivery (p<0.05.) between 2001 and 2006.

Conclusion:
Water birth is a value and promising alternative to traditional delivery methods. During water birth, faeces are discharged into the pool and the water is contaminated with a variety of microorganisms. However, contamination of the water does not appear to translate into an increased risk of neonatal infection. However based on our results and the literature, water birth is a valuable alternative to traditional delivery when certain criteria are met and risk factors are excluded.

Key words: water birth, microbiological colonization, delivery, infections, fetal outcome
Introduction

In Europe an increasing number of women want to give birth in the water. In our institution we perform water deliveries since 1996, about 40 – 50 % of approximately 530 women per year give birth in the water.

Since the first reports on water birth were published more than 20 years ago (1, 2,3); there have been ongoing debate about the safety, potential risks and general outcome.

Main advantages of water birth have been reported to be a decrease in episiotomy rate, pain medication and epidural anaesthesia (4). Also, maternal blood loss was observed to be lower after delivery in the water whereas fetal outcome, maternal infection rate did not differ between the two groups (3).

One main concern, continuously reiterated by hygienists (5) obstetricians (6,7) and neonatologists, remains microbiological contamination of the mother and the newborn after water delivery due the faecal and skin flora of the mother and environmental bacteria from the water system. Because the water is at body temperature, bacteria can multiply quickly and infect both the newborn and the mother after a water birth (8, 9).

Therefore the aim of this study was to analyze the microbial contamination of the bath water, by analyzing 2 samples, one after filling the pool, the other after the delivery the newborn.

Additionally we compare fetal outcome data and neonatal infection rate after deliveries in the water with those born conventionally.

Materials and Methods

During the period from 2001 to 2006, a total of 1407 water births were recorded at the Women`s Hospital of Vipiteno, Italy, in addition to those 982 vaginal deliveries, excluding the deliveries done by caesarean section.

A prospective study was done in cooperation with the Biological Laboratory of the Environmental Agency of the Province of Bolzano (9), and from 2001 onwards, the water in the birthing pool was sampled for micro-organisms. The microbiological composition of the water was determined in 300 of the total 1407 water births. Of the 300 water births analyzed, 125
occurred before the installation of the Aquasafe FilterR (PALL) system into the supply hose for the birthing pool and, 175 occurred afterwards.

Two water samples were taken for microbial analysis at each delivery. For sample A, the water was taken using a sterile bottle immediately after the pool was filled with water. Sample B was taken after the mother had left the birthing pool after the delivery. Both samples were transported to the laboratory, where the tests took place within 24 hours of sampling. Six parameters were analyzed for the A samples and five parameters were analyzed for the B samples (Table 1). The A samples were analyzed for the standard hygiene indicators such as coliforms, Escherichia coli, Enterococci, Pseudomonas aeruginosa and Legionella pneumophila, which can form biofilms on warm water pipe surfaces (9). The total microbial count indicates the general bio-burden.

Laboratory standard values:
The water was not considered contaminated if the number of hygiene indicators in 100 mL was 0 (following the general water requirements for human use), there was no evidence of Legionella in 1 mL, and the total microbial count was <-500 CFU/1 mL (Table 2).

In the water samples collected after delivery (B samples), five parameters were examined. They were mainly influenced by the contamination of the pool with maternal faeces. In addition to the coliforms, Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, and Candida spp. were cultivated.

All neonates underwent a daily physical examination (11). If there were clinical indications of an ensuing infection, a septic screen including CRP and white blood count testing was performed. Any local infection such as conjunctivitis and inflammation of the navel was documented (12). In addition, a leukocyte count was performed on day 1 or 2 after delivery for the 300 women who delivered in water and compared with the leukocyte count for another 300 women who had undergone conventional delivery.

Statistical analysis was performed with commercial software SPSS 11.5 (SPSS, Inc., Chicago, USA). Student’s t test and Welch test (if variances in groups are unequal) were used to compare approximate normally distributed data in the groups. Mann-Whitney U test or χ²-test
was used for the ordinal data. All variables used were described by median and standard deviation. A P value < 0.05 was considered significant.

Results
The results are listed in Figure 1 and 2 and in Table 3.
Since bacterial growth with Legionella (29%) and Pseudomonas (22%) was repeatedly found in the A-samples (diagram 1), we thus decided to install the Aquasafe single use water filter system in the supply hoses for the birthing pool. This intervention significantly reduced the total microbial count from 53% to 11%, and there was no longer evidence of Legionella pneumophila. The contamination with Pseudomonas aeruginosa was reduced from 22% to 3%. Contamination with coliforms was reduced from 32% to 13% by thoroughly cleaned the tub.
A further reduction of microbiological loading with Coliforms and Enterococci in the birthing pool after it was filled was reached by adoption of a new cleaning protocol for the birthing pool. (The pool was first cleaned with a detergent and then disinfected with a chlorhexidine product - unpublished data). (Fig. 1)
Faeces are discharged into the birthing pool water during the bearing down phase of childbirth. Thus, the water was contaminated with a large variety of micro-organisms (diagram 2), including micro-organisms from the mother’s skin. Consequently, the B-samples taken from the pool after a water birth showed the presence of coliform loading before and after installation of the filter system in 92% and 88% of the samples, respectively. In 79% and 76% of the samples, there was evidence of contamination with Escherichia coli. Concentrations of up to 105 CFU/100 mL were measured for Escherichia coli and coliforms. On the other hand, loading was moderate with Pseudomonas aeruginosa (26% before installation of the filter system compared with 20% afterwards), Staphylococcus aureus (4% before installation of the filter system compared with 8% afterwards) and Candida spp (20% before installation of the filter system compared with 22% afterwards). By comparing the microbiological composition of the B-samples before and after installation of the filter system, we concluded that the intervention did not influence the
microbial loading of the water, which occurred during and as a result of the whole delivery phase. (Fig. 2)

On average, the mothers` white blood count (WBC) did not show any significant difference between the two groups on the first or second day after delivery. The WBC for water births was 11.014/µL (6,200 — 16,900) compared with 11.210/µL (5,300 — 18,700) for conventional deliveries.

Although there was a high level of contamination with faecal bacteria in the water after birth, children born in water did not have an increased infection rate. Notably, there was no increase in the rate of focal skin infections around the umbilicus or eye infections such as conjunctivitis. There were fewer signs of infection in the children born in water, 1.13% of them showed symptoms of tachypnoea, flared nostrils, abnormal skin coloring, and increased CRP values compared with 2.03% of the children born conventionally (P < 0.05) (Table 2). All neonates with these signs of infection were treated with antibiotic.

Discussion

A number of concerns were expressed about water births when they were first introduced. In the last few years, there have been a number of case reports of infections in children born in water (14, 15, 16). Our prospective study concentrated on the hygienic aspects of water births. After birth, the water showed an increased amount of faecal indicators. There was evidence of total coliforms and Escherichia coli concentrations of up to 105 CFU/100mL. Staphylococcus aureus, Pseudomonas aeruginosa, Candida spp were also detected. However, this considerable loading did not cause an increase in the rate of neonatal infections in water births when compared with conventional births. There was also no increase in the number of maternal infections or poor healing of perineal tears in women who had given birth in water. These observations further expand and confirm the studies by Gilbert (17) and Kramer (18), who did not find an increased rate of infection in children born in water. The water in the birthing pool was at body temperature and came from the public water supply, which is regularly checked by the health authorities. The contamination could have come from the peripheral pipe system of the hospital (11), but it may
also have resulted from improper cleaning and disinfection of the pool (14). After installation of the filter there was a significant reduction in the contamination of the sample A pool water with micro-organisms, which predominantly originated from the plumbing system (Legionella, Pseudomonas aeruginosa, total microbial count). However, Pseudomonas aeruginosa can also be carried by infected mothers and other sources of infection. Thus, it is not possible to completely eliminate this germ. On the other hand, the reduction of the standard hygiene indicators such as total coliforms, Escherichia coli and enterococci was only minimal. Total coliforms, Escherichia coli, and enterococci are normally tested for in the drinking water on a regular basis by the local health authorities, which had not verified the presence of such organisms as of yet. One can therefore assume that these microbiological indicators provide information on the hygienic conditions of the birthing pool.

Our study shows that the microbiological loading of the water in the birthing pool after it was filled may have partly originated from the insufficient quality of the drinking water which was heated to body temperature, and partly from the insufficient cleaning and disinfection of the birthing pool. In the testing phase of the birthing pool after 2002, the cleaning protocol was changed (the pool was first cleaned with a detergent and then disinfected with a chlorhexidine product), and there was no longer any evidence of a significant microbial count (unpublished data). The water samples taken in the first few years after the installation of the birthing pool repeatedly showed increased levels of Legionella pneumophila (microbial count >10^3/L) and there was evidence of an increased concentration of these organisms in the shower hose, which occurred as a result of water stagnation. Drinking water does not have to be sterile to meet the requirements of the drinking and bathing water ordinance, and water can become contaminated in a hospital’s plumbing system (11), thus, contamination of hospital drinking water with e.g. Pseudomonas aeruginosa or Legionella, as well as severe hospital-acquired infections, have repeatedly been described in babies born in water (19,20,21). In 2001, the first year of the study period, attempts were made to eradicate Legionella by heating the water tank to over 60°C every day. However, these measures failed to clear the tap water. The contamination of heated drinking water was not reduced or controlled until the filter system was installed in 2002 (10).
The Aquasafe® single use water filters are delivered under sterile conditions and are changed before filling the birthing pool for each birth. The filters are installed at the end of the shower hose and the filter outlet is not allowed to dip into the pool water, i.e. care must be taken that it does not come into contact with the water in the birthing pool during the delivery, in order to rule out retrograde contamination of the filter outlet with micro-organisms in the water. The filters must be changed in no later than seven days, even if they have not been used or if there have not been any water births. The filters undergo antibacterial treatment, although the new generation of water filters (Pall Medical disposable, single use water filters) offers the advantage that they do not have to be decontaminated. Comparing the results of the B-samples, which were taken after the water birth, shows that there was no significant improvement in the microbiological composition of the water after the filter system was installed, as the loading occurred as a result of the delivery. There was, however no evidence of the complications expected as a result of water births, such as aspiration and increased infections for the neonate. This is probably due to the fact that the intrauterine diving or breath holding reflex remains fully effective during delivery and immediately afterwards in the water (22, 23, 24). It is therefore physiologically impossible for the micro-organisms excreted in the mother’s faeces to enter the neonate’s lungs and cause an infection.

In summary, both maternal faeces and the water supply are sources of contamination with potentially pathogenic micro-organisms. However, water birth was not associated with an increased risk of neonatal or maternal infections in our series. Our data indicate that water deliveries are safe and not associated with adverse maternal or fetal outcome, when water supply system and bathing tube are serviced appropriately.

Acknowledgement This study was supported by a grant from the Autonomic Province of Bolzano/Italy. There are no conflicts of interest to declare.
References

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20. Franzin L et al. Legionella pneumophila Pneumonia in a Newborn after Water Birth: A New Mode of Transmission, Clinical Infectious Diseases 2001; 33e, 103-104
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Methods</th>
<th>Examination</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliforms</td>
<td>Stand. Meth. 20th ed. 9222B</td>
<td>After filling the pool and after delivery (Sample A and B)</td>
<td>Standard hygiene indicators in the examination of drinking water or bathing water; increased values also indicate insufficient cleaning and disinfection of the pool</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>MU 1185:2001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterococci</td>
<td>ISO 7899-2:2000</td>
<td></td>
<td>Can accumulate in furred pipes and reservoirs</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Internal methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total microbial count</td>
<td>ISO 6222:2000</td>
<td>After filling pool (Sample A)</td>
<td>General microbiological loading Can multiply in hot water pipes and water reservoirs</td>
</tr>
<tr>
<td>Legionella pneumophila</td>
<td>ISO 11731: 1998</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococcus aureus,</td>
<td>Internal methods</td>
<td>After delivery (Sample B)</td>
<td>Originate mainly from skin and mucous membranes</td>
</tr>
<tr>
<td>Candida spp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters</td>
<td>Criteria</td>
<td>Unit</td>
<td>Valuation</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Coliforms, <em>Escherichia coli</em>, <em>Pseudomonas aeruginosa</em>, <em>Staphylococcus</em></td>
<td>&lt;= 100 KBE/100ml</td>
<td></td>
<td>not contaminated</td>
</tr>
<tr>
<td>Enterococci, Yeasts</td>
<td>&gt; 100 KBE/100ml</td>
<td></td>
<td>slightly contaminated</td>
</tr>
<tr>
<td>Total microbial loading</td>
<td>&lt; 500 KBE/1ml</td>
<td></td>
<td>not contaminated</td>
</tr>
<tr>
<td></td>
<td>&gt;= 500 bis &lt; 1,000 KBE/1ml</td>
<td></td>
<td>slightly contaminated</td>
</tr>
<tr>
<td></td>
<td>&gt; 1,000 KBE/1ml</td>
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<td>contaminated</td>
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<tr>
<td><em>Legionella pneumophila</em></td>
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<td></td>
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<tr>
<td></td>
<td>detectable P/A in 1 ml</td>
<td></td>
<td>contaminated</td>
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Table 3: Clinical findings for neonates

<table>
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<tr>
<th>Method of delivery</th>
<th>Conventional birth n = 982</th>
<th>Water birth n = 1407</th>
<th>p- value</th>
</tr>
</thead>
<tbody>
<tr>
<td>clinical signs of infection and respiratory distress</td>
<td>20 out of 982 (2.03%)</td>
<td>16 out of 1407 (1.13%)</td>
<td>p = 0.119</td>
</tr>
<tr>
<td>CRP (mg/dL) (normal value &lt; 0.8)</td>
<td>2.82 ± 1.82</td>
<td>1.5 ± 0.2</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>umbilical artery blood pH</td>
<td>7.25 (7.03 — 7.46)</td>
<td>7.26 (7.04 — 7.47)</td>
<td>p = 0.695</td>
</tr>
<tr>
<td>Base Excess mmol/L</td>
<td>-6.05 (-0.2 — 13.8)</td>
<td>-5.35 (-0.6 — 13.2)</td>
<td>p = 0.513</td>
</tr>
</tbody>
</table>
Figure 1: Microbiological composition of the A-samples (birthing pool water after the tub was filled with tap water),
A) before installation of the filter system (n =125)

B) after the installation of the Filter System (n=175)
Figure 2: Microbiological composition of the B-samples (water taken after delivery) (n = 300) after installation of the filter and adoption of different cleaning record.