

Socialization of corner care in newborn babies as an efforts to prevent infections in the corner at PMB ernita pekanbaru

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ABSTRACT

The umbilical cord or in medical terms known as the umbilical funiculus is a lifeline for the fetus during the womb. Caring for the umbilical cord is also important to prevent neonatal tetanus, which can cause death. The body of a newborn baby is not strong enough to ward off infectious germs. Based on the results of the survey, it was found that mothers who had babies aged 0-7 days did the wrong umbilical cord care. Of the 5 pregnant women found, 2 of them still use spices (turmeric) to speed up the delivery of the umbilical cord. In PMB Ernita in the last 6 months has never done any counseling related to umbilical cord care. So it is necessary to carry out activities to overcome the problems found through the socialization of umbilical cord care for mothers. The target of this activity is to increase knowledge about proper umbilical cord care so that it can change the mother's behavior in caring for the newborn's umbilical cord. The results of this activity will be published in the community service journal of Muhammadiyah University of Riau. This activity was carried out in 2 stages: 1. Counseling was carried out on November 16, 2020, 2. The stage of coaching, monitoring and evaluation was carried out for 1 week with home visits from November 23 - 29 2020. The results of this activity were 1) Increased knowledge of mothers who have a baby about the correct care of the umbilical cord is seen from the ability of the baby's mother in answering the questions posed by the speaker, of the 10 questions given by the speaker can be answered by the baby's mother. 2) Increasing the skills of the baby's mother in properly caring for her own umbilical cord, so that it is possible for participants to apply these skills in daily life. This can be seen when the service team makes home visits. It is hoped that health workers in this case midwives can prepare postpartum mothers in caring for newborns, especially umbilical cord care starting from pregnancy.

KEYWORDS

Umbilical cord care;
Newborns;
Infection prevention



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1. Introduction

The umbilical cord or in medical terms known as the umbilical funiculus is a lifeline for the fetus during the womb. The umbilical cord has been studied by previous researchers. Patent urachus or bladder exstrophy occulta? A case of umbilical cord cyst that disappeared before birth was studied by Chien [1]. Iron Chains in Cord Blood Hematopoietic Stem Cell Transplantation: Comment on "Iron Associated with Delayed Engraftment and Increased Nonrelapsed Mortality in Cord Blood Hematopoietic Cell Transplant Recipients" studied by Knovich [2]. Low-dose Methotrexate May Reduce Severe Initial Immune Reactions but May Increase Graft Failure in Cord Blood Transplant studied by Huilan [3]. The combination of Donor KIR3DL1/HLA-Bw4-80I Receptor Reduces Recurrence of Acute Leukemia after Cord Blood Transplantation without In Vitro T Cell Depletion was studied by Fang [4]. Durable Chimerism and Long-Term Survival after Unrelated Cord Blood Transplantation for Pediatric Hemophagocytic Lymphohistiocytosis: A One Center Experience studied by Patel [5].

Cord blood-soluble Fas ligand associated with allergic rhinitis and lung function in seven-year-old children was studied by Su [6]. The effect of conditioned media of human umbilical cord blood-derived mesenchymal stem cells on the skin immune response was investigated by Kim [7]. Evaluation of umbilical cord pulsatility after vaginal delivery in singleton pregnancies at term was studied by Di Tommaso [8].

Post-Transplant Prophylaxis with High-dose Valacyclovir up to Day 100 Versus Post-Transplant Hospital Discharge Reduces Cytomegalovirus Reactivation in Adult Cord Blood Transplant Recipients studied by Sharma [9]. Angiogenic Factors Associated with T-cell Immune Reconstitution and Clinical Outcome After Dual Unit Cord Blood Transplantation in Adults was investigated by Politicos [10].

The term umbilical cord management of the newborn was studied by Andersson [11]. The validation of the single-platform ISHAGE protocol for the counting of CD34+ hematopoietic stem cells in umbilical cord blood in central Brazil was studied by Pedrosa de Lira de Moraes [12]. Human umbilical cord perivascular cells: A novel source of the organophosphate antidote butyrylcholinesterase was investigated by Braid [13]. A Modified Intensive Strategy to Prevent Cytomegalovirus Disease in Seropositive Cord Blood Transplant Recipients was studied by Hill [14]. Cord Blood Transplant without Antithymocyte Globulin Resulting in Equal Survival but Better Quality of Life Compared to Unrelated Peripheral Blood Stem Cell Transplant for Treatment of Acute Leukemia—A Retrospective Study on the Chin studied by Tong by [15].

A new study on the immunomodulatory effect of umbilical cord-derived mesenchymal stem cells treated with the traditional Chinese medicine Asarinin was investigated by He [16]. Multiple administrations of umbilical cord-derived MSCs attenuated the development of rat osteoarthritis by preserving cells of the superficial layer of articular cartilage and inhibiting synovitis studied by Tong [17]. Recommendations for umbilical cord care in newborns were investigated by Leante Castellanos [18]. Cord blood expansion was studied by Lund [19]. Ex Vivo Expanded Umbilical Cord Blood (NiCord) Transplantation Reducing Early Infection and Hospitalization was investigated by Anand [20].

Autoimmune haematological complications of cord blood transplantation were investigated by Ibrahim [21]. A Phase 2 Prospective Study of Cord Blood Transplantation in Adult Acute Leukemia and Adult Myelodysplastic Syndrome was investigated by Terakura [22]. Cord blood transplantation using reduced-intensity conditioning without antithymocyte globulin in adult patients with severe aplastic anemia was studied by Ochi [23]. Successful Cord Blood Transplantation in Recurring Acute B-Cell Lymphoblastic Leukemia After Chimeric Antigen Receptor Therapy was studied by Liu [24]. Comparison of umbilical cord arterial blood lactate and pH values for predicting short-term neonatal outcomes was studied by Einikyte [25].

According to the Who Health Organization (WHO) the proportion of newborn deaths in the world is very high with an estimated 4 million newborn deaths per year and 1.4 million deaths in newborns in the first month in Southeast Asia. Estimates of deaths that occur due to tetanus are around 550,000, more than 50% of deaths that occur in Africa and Southeast Asia are due to infection in the umbilical cord in general being the main entry point for bacteria, especially when something unsterile is given. Previous researchers have researched about tetanus. The engineering of a new vaccine platform for delivery of heterologous antigens in directly attenuated Mycobacterium tuberculosis was investigated by Broset [26]. A review of the costs of maternal immunization during pregnancy was investigated by Procter [27]. A combination of human monoclonal oligoclonal antibodies capable of neutralizing tetanus toxin in vivo was investigated by Aliprandini [28]. Tetanus – A Rare But Real Threat researched by Moynan [29]. A randomized study of fever prophylaxis and immunogenicity of routine pediatric vaccination was investigated by Wysocki [30].

Monitoring progress on maternal and infant immunization in Latin America and the Caribbean was studied by Velandia-González [31]. The incidence and mortality of pertussis in infants <12 months after the introduction of universal mass vaccination of maternal pertussis in Bogotá, Colombia was studied by Carrasquilla [32]. Low coverage of the tetanus-diphtheria-acellular pertussis (Tdap) vaccine among health workers in a quaternary university hospital in São Paulo, Brazil: the need for ongoing surveillance and implementation of active strategies was investigated by Randi [33]. The immunogenicity and protective efficacy of the newly developed acellular diphtheria, tetanus, and pertussis tri-component vaccine in a

murine model was investigated by Huh [34]. The epidemiological and clinical aspects of neonatal tetanus from a tertiary care hospital were investigated by Aqeel [35]. Burden of neurological disorders across Indian states: The Global Burden of Disease Study 1990–2019 studied by Singh [36]. Seroprevalence of antibodies to diphtheria, tetanus, and pertussis among healthy Thai adolescents was studied by Hanvatananukul [37]. Adjuvant recombinant zoster vaccine coadministered with tetanus, diphtheria, and pertussis vaccines in adults aged 50 years: A randomized trial studied by Strežova [38]. Targeting Mesothelin Immunotherapy in Acute Myeloid Leukemia In Vitro with Anetumab Ravtansine and New Antibody Drug Conjugate was investigated by Kaeding [39]. Tetanus immune status among adult trauma patients in the ED was studied by Toker [40].

Optimizing the tetanus-diphtheria-pertussis 6-plex fluorescent bead-based immunoassay was studied by McAlister [41]. Duplication of clostridial binding domains to enhance delivery of macromolecules into neurons was investigated by Leese [42]. The chemokine/cytokine profile of TH1/TH2 in mice treated with tetanus toxoid and *Euphorbia tirucalli* was studied by Ibrahim [43]. Immunization of premature infants with the GSK hexavalent combination vaccine diphtheria-tetanus-acellular pertussis-hepatitis B-inactivated poliovirus-Haemophilus influenzae type b conjugate vaccine: A review of safety and immunogenicity studied by Omeñaca [44]. Immunogenicity and safety of a new low-dose tetanus-diphtheria vaccine in healthy Korean adolescents: A comparative, double-blind, randomized, multicenter phase III active control study studied by Han [45]. The identification of a strong regulatory T cell epitope in factor V that modulates the response of CD4+ and CD8+ memory T cells was investigated by De Groot [46]. Fluorescent Studies on the Tetanus Neurotoxin were investigated by ONeil [47]. Observational study of non-specific effects of Diphtheria-Tetanus-Pertussis vaccine in low-income countries: Assessing the potential impact of study characteristics, biases and confounders through meta-regression investigated by Bollaerts [48]. Treating insect bite hypersensitivity in horses with active vaccination against IL-5 was investigated by Fettelschoss-Gabriel [49]. Introduction of Diphtheria-Tetanus-Pertussis and Oral Polio Vaccines in Young Infants in African Urban Communities: Natural Experiments studied by Mogensen [50].

Caring for the umbilical cord is also important to prevent neonatal tetanus, which can cause death. The body of a newborn baby is not strong enough to ward off infectious germs. Therefore, the umbilical cord must be clean and dry until the umbilical cord dries, shrinks, and separates from the baby's center. The lack of information provided by health workers so that the mother's knowledge about the importance of umbilical cord care is very lacking and as a result the infection rate in newborns is high. Often mothers who have babies perform umbilical cord care by following local customs and culture and as a result the infection rate in newborns is high. From these problems, the contribution of this activity is that it is necessary to hold training on how to care for the umbilical cord. This activity contributes to postpartum mothers and health workers themselves who do not know how to care for the umbilical cord with the latest methods of umbilical cord care. With the training, the health workers together with the cadres can teach the correct way of caring for the umbilical cord to postpartum mothers. After conducting outreach efforts to increase public awareness about umbilical cord care carried out by PMB Ernita, it is hoped that the surrounding community can apply it, so as to create a comfortable, peaceful and prosperous family.

2. Method

The method of community service carried out is as follows:

2.1. Counseling

Conducting outreach activities with the theme "Socialization of umbilical cord care in newborns as an effort to prevent infection in the umbilical cord at PMB Ernita Pekanbaru" the method carried out by providing direct counseling with leaflets containing materials as well as questions and answers about materials conducted online.

2.2. Coaching, monitoring and evaluation

- Coaching, carried out through home visits
- Monitoring, intended to observe activities carried out by cadres for postpartum mothers
- Evaluation, looking at the results carried out by cadres on postpartum mothers whether they have met

3. Results and Discussion

Community service activities regarding the socialization of umbilical cord care in infants as an effort to prevent infection at PMB Ernita, were carried out online with the zoom application and home visits for coaching activities is shown in Fig. 1. The counseling participants consisted of 15 postpartum mothers (days 1-7). This activity was carried out in 2 stages. Counseling held on November 16, 2020.



Fig. 1. Extension of umbilical cord care socialization



Fig. 2. The service team makes a home visit

The coaching, monitoring and evaluation stage is carried out for 1 week with home visits from 23 - 29 November 2020 shown in Fig. 2. The picture shows that based on interviews, questions and answers

and direct observations and inspections during the activity, this community service activity gave results. The increasing knowledge of mothers who have babies about correct care of the umbilical cord can be seen from the ability of the baby's mother to answer the questions posed by the speaker, of the 10 questions given by the speaker the mother of the baby can answer.

The mother can take care of the baby's umbilical cord at home, as shown in Fig. 3. The Fig. 3 shows that the mother's skills in properly caring for the baby's umbilical cord are increased, so that it is possible for participants to apply these skills in everyday life. This can be seen when the service team makes home visits.



Fig. 3. Care of the baby's umbilical cord

4. Conclusion

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).

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Author Contribution

The contribution of this activity is that it is necessary to hold training on how to care for the umbilical cord. This activity contributes to postpartum mothers and health workers themselves who do not know how to care for the umbilical cord with the latest methods of umbilical cord care.

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Conflict of Interest

The authors declare no conflict of interest.

References

- [1] C.-W. Chien, K.-J. Chen, J.-Y. Lai, and A.-S. Chao, "Patent urachus or bladder exstrophy occulta? A case of prenatally disappeared umbilical cord cyst," *Urol. Case Reports*, vol. 39, p. 101772, Nov. 2021, doi: [10.1016/j.eucr.2021.101772](https://doi.org/10.1016/j.eucr.2021.101772).
- [2] M. A. Knovich, "Chains of Iron in Umbilical Cord Blood Hematopoietic Stem Cell Transplantation: Comment on 'Iron Overload Is Associated with Delayed Engraftment and Increased Nonrelapse Mortality in Recipients of Umbilical Cord Blood Hematopoietic Cell Transplantation' b," *Biol. Blood Marrow Transplant.*, vol. 26, no. 9, pp. e213–e214, Sep. 2020, doi: [10.1016/j.bbmt.2020.07.012](https://doi.org/10.1016/j.bbmt.2020.07.012).
- [3] L. Huilan et al., "Low-Dose Methotrexate Could Reduce Severe Early Immune Reactions but Probably Increase Graft Failure in Umbilical Cord Blood Transplantation," *Blood*, vol. 134, pp. 5679–5679, Nov. 2019, doi: [10.1182/blood-2019-131524](https://doi.org/10.1182/blood-2019-131524).
- [4] X. Fang, Z. Sun, H. Liu, and L. Xia, "Donor KIR3DL1/Receptor HLA-Bw4-80I Combination Reduce Acute Leukemia Relapse after Umbilical Cord Blood Transplantation without in Vitro T-Cell Depletion," *Blood*, vol. 132, pp. 3420–3420, Nov. 2018, doi: [10.1182/blood-2018-99-117775](https://doi.org/10.1182/blood-2018-99-117775).
- [5] S. A. Patel et al., "Durable Chimerism and Long-Term Survival after Unrelated Umbilical Cord Blood Transplantation for Pediatric Hemophagocytic Lymphohistiocytosis: A Single-Center Experience," *Biol. Blood Marrow Transplant.*, vol. 23, no. 10, pp. 1722–1728, Oct. 2017, doi: [10.1016/j.bbmt.2017.06.013](https://doi.org/10.1016/j.bbmt.2017.06.013).
- [6] K. W. Su et al., "Cord blood soluble Fas ligand linked to allergic rhinitis and lung function in seven-year-old children," *J. Microbiol. Immunol. Infect.*, vol. 55, no. 2, pp. 300–306, Apr. 2022, doi: [10.1016/j.jmii.2021.03.016](https://doi.org/10.1016/j.jmii.2021.03.016).
- [7] Y.-J. Kim, H.-J. Ahn, S.-H. Lee, M.-H. Lee, and K.-S. Kang, "Effects of conditioned media from human umbilical cord blood-derived mesenchymal stem cells in the skin immune response," *Biomed. Pharmacother.*, vol. 131, p. 110789, Nov. 2020, doi: [10.1016/j.biopha.2020.110789](https://doi.org/10.1016/j.biopha.2020.110789).
- [8] M. Di Tommaso et al., "Evaluation of umbilical cord pulsatility after vaginal delivery in singleton pregnancies at term," *Eur. J. Obstet. Gynecol. Reprod. Biol.*, vol. 236, pp. 94–97, May 2019, doi: [10.1016/j.ejogrb.2019.03.008](https://doi.org/10.1016/j.ejogrb.2019.03.008).
- [9] P. Sharma et al., "Post Transplant Prophylaxis with High Dose Valacyclovir through Day 100 Versus Day of Post Transplant Hospital Discharge Decreases Cytomegalovirus Reactivation in Adult Umbilical Cord Blood Transplant Recipients," *Blood*, vol. 132, pp. 4659–4659, Nov. 2018, doi: [10.1182/blood-2018-99-110211](https://doi.org/10.1182/blood-2018-99-110211).
- [10] I. Politikos et al., "Angiogenic Factors Correlate with T Cell Immune Reconstitution and Clinical Outcomes after Double-Unit Umbilical Cord Blood Transplantation in Adults," *Biol. Blood Marrow Transplant.*, vol. 23, no. 1, pp. 103–112, Jan. 2017, doi: [10.1016/j.bbmt.2016.10.013](https://doi.org/10.1016/j.bbmt.2016.10.013).
- [11] O. Andersson and J. S. Mercer, "Cord Management of the Term Newborn," *Clin. Perinatol.*, vol. 48, no. 3, pp. 447–470, Aug. 2021, doi: [10.1016/j.clp.2021.05.002](https://doi.org/10.1016/j.clp.2021.05.002).
- [12] C. C. Pedrosa de Lira de Moraes, J. Dias Alves Pinto, K. Wagner de Souza, M. Izu, L. Fernando da Silva Bouzas, and F. Henrique Paraguassú-Braga, "Validation of the single-platform ISHAGE protocol for enumeration of CD34+ hematopoietic stem cells in umbilical cord blood in a Brazilian center," *Hematol. Transfus. Cell Ther.*, vol. 44, no. 1, pp. 49–55, Mar. 2022, doi: [10.1016/j.htct.2020.09.151](https://doi.org/10.1016/j.htct.2020.09.151).
- [13] L. R. Braid, C. A. Wood, and B. N. Ford, "Human umbilical cord perivascular cells: A novel source of the organophosphate antidote butyrylcholinesterase," *Chem. Biol. Interact.*, vol. 305, pp. 66–78, May 2019, doi: [10.1016/j.cbi.2019.03.022](https://doi.org/10.1016/j.cbi.2019.03.022).
- [14] J. A. Hill et al., "A Modified Intensive Strategy to Prevent Cytomegalovirus Disease in Seropositive Umbilical Cord Blood Transplantation Recipients," *Biol. Blood Marrow Transplant.*, vol. 24, no. 10, pp. 2094–2100, Oct. 2018, doi: [10.1016/j.bbmt.2018.05.008](https://doi.org/10.1016/j.bbmt.2018.05.008).
- [15] J. Tong et al., "Umbilical Cord Blood Transplantation without Antithymocyte Globulin Results in Similar Survival but Better Quality of Life Compared with Unrelated Peripheral Blood Stem Cell Transplantation for the Treatment of Acute Leukemia—A Retrospective Study in Chin," *Biol. Blood Marrow Transplant.*, vol. 23, no. 9, pp. 1541–1548, Sep. 2017, doi: [10.1016/j.bbmt.2017.05.004](https://doi.org/10.1016/j.bbmt.2017.05.004).
- [16] H. He, T. Yang, F. Li, L. Zhang, and X. Ling, "A novel study on the immunomodulatory effect of umbilical cord derived mesenchymal stem cells pretreated with traditional Chinese medicine Asarinin," *Int. Immunopharmacol.*, vol. 100, p. 108054, Nov. 2021, doi: [10.1016/j.intimp.2021.108054](https://doi.org/10.1016/j.intimp.2021.108054).
- [17] W. Tong et al., "Multiple umbilical cord-derived MSCs administrations attenuate rat osteoarthritis progression via preserving articular cartilage superficial layer cells and inhibiting synovitis," *J. Orthop. Transl.*, vol. 23, pp. 21–28, Jul. 2020, doi: [10.1016/j.jot.2020.03.007](https://doi.org/10.1016/j.jot.2020.03.007).

- [18] J. L. Leante Castellanos et al., "Recommendations for the care of the umbilical cord in the newborn," *An. Pediatria* (English Ed., vol. 90, no. 6, pp. 401.e1-401.e5, Jun. 2019, doi: [10.1016/j.anpede.2019.01.009](https://doi.org/10.1016/j.anpede.2019.01.009).
- [19] T. C. Lund, "Umbilical Cord Blood Expansion: Are We There Yet?," *Biol. Blood Marrow Transplant.*, vol. 24, no. 7, pp. 1311–1312, Jul. 2018, doi: [10.1016/j.bbmt.2018.05.002](https://doi.org/10.1016/j.bbmt.2018.05.002).
- [20] S. Anand et al., "Transplantation of Ex Vivo Expanded Umbilical Cord Blood (NiCord) Decreases Early Infection and Hospitalization," *Biol. Blood Marrow Transplant.*, vol. 23, no. 7, pp. 1151–1157, Jul. 2017, doi: [10.1016/j.bbmt.2017.04.001](https://doi.org/10.1016/j.bbmt.2017.04.001).
- [21] U. Ibrahim and A. Keyzner, "Autoimmune hematologic complications of umbilical cord blood transplantation," *Hematol. Oncol. Stem Cell Ther.*, vol. 14, no. 2, pp. 104–109, 2021, doi: [10.1016/j.hemonc.2020.07.009](https://doi.org/10.1016/j.hemonc.2020.07.009).
- [22] S. Terakura et al., "Prospective Phase 2 Study of Umbilical Cord Blood Transplantation in Adult Acute Leukemia and Myelodysplastic Syndrome," *Biol. Blood Marrow Transplant.*, vol. 26, no. 1, pp. 139–144, Jan. 2020, doi: [10.1016/j.bbmt.2019.09.021](https://doi.org/10.1016/j.bbmt.2019.09.021).
- [23] T. Ochi et al., "Umbilical Cord Blood Transplantation Using Reduced-Intensity Conditioning without Antithymocyte Globulin in Adult Patients with Severe Aplastic Anemia," *Biol. Blood Marrow Transplant.*, vol. 25, no. 2, pp. e55–e59, Feb. 2019, doi: [10.1016/j.bbmt.2018.09.039](https://doi.org/10.1016/j.bbmt.2018.09.039).
- [24] F. Liu, X. Zhu, Y. Guo, X. Chen, and M. Ruan, "Successful Umbilical Cord Blood Transplantation in Relapsed B-Cell Acute Lymphoblastic Leukemia after Chimeric Antigen Receptors Therapy," *Blood*, vol. 132, pp. 5774–5774, Nov. 2018, doi: [10.1182/blood-2018-99-118452](https://doi.org/10.1182/blood-2018-99-118452).
- [25] R. Einikyte et al., "The comparison of umbilical cord arterial blood lactate and pH values for predicting short-term neonatal outcomes," *Taiwan. J. Obstet. Gynecol.*, vol. 56, no. 6, pp. 745–749, Dec. 2017, doi: [10.1016/J.TJOG.2017.10.007](https://doi.org/10.1016/J.TJOG.2017.10.007).
- [26] E. Broset et al., "Engineering a new vaccine platform for heterologous antigen delivery in live-attenuated *Mycobacterium tuberculosis*," *Comput. Struct. Biotechnol. J.*, vol. 19, pp. 4273–4283, Jan. 2021, doi: [10.1016/J.CSBj.2021.07.035](https://doi.org/10.1016/J.CSBj.2021.07.035).
- [27] S. R. Procter et al., "A review of the costs of delivering maternal immunisation during pregnancy," *Vaccine*, vol. 38, no. 40, pp. 6199–6204, Sep. 2020, doi: [10.1016/j.vaccine.2020.07.050](https://doi.org/10.1016/j.vaccine.2020.07.050).
- [28] E. Aliprandini, D. Y. Takata, A. Lepique, J. Kalil, S. B. Boscardin, and A. M. Moro, "An oligoclonal combination of human monoclonal antibodies able to neutralize tetanus toxin in vivo," *Toxicon X*, vol. 2, p. 100006, Apr. 2019, doi: [10.1016/j.toxcx.2019.100006](https://doi.org/10.1016/j.toxcx.2019.100006).
- [29] Moynan, R. O'Riordan, R. O'Connor, and C. Merry, "Tetanus – A Rare But Real Threat," *IDCases*, vol. 12, pp. 16–17, Jan. 2018, doi: [10.1016/J.IDCR.2018.02.004](https://doi.org/10.1016/J.IDCR.2018.02.004).
- [30] J. Wysocki et al., "A randomized study of fever prophylaxis and the immunogenicity of routine pediatric vaccinations," *Vaccine*, vol. 35, no. 15, pp. 1926–1935, Apr. 2017, doi: [10.1016/j.vaccine.2017.02.035](https://doi.org/10.1016/j.vaccine.2017.02.035).
- [31] M. Velandia-González et al., "Monitoring progress of maternal and neonatal immunization in Latin America and the Caribbean," *Vaccine*, vol. 39, pp. B55–B63, Jul. 2021, doi: [10.1016/j.vaccine.2020.12.043](https://doi.org/10.1016/j.vaccine.2020.12.043).
- [32] G. Carrasquilla et al., "Incidence and mortality of pertussis disease in infants <12 months of age following introduction of pertussis maternal universal mass vaccination in Bogotá, Colombia," *Vaccine*, vol. 38, no. 46, pp. 7384–7392, Oct. 2020, doi: [10.1016/j.vaccine.2020.07.046](https://doi.org/10.1016/j.vaccine.2020.07.046).
- [33] B. A. Randi et al., "Low tetanus-diphtheria-acellular pertussis (Tdap) vaccine coverage among healthcare workers in a quaternary university hospital in São Paulo, Brazil: need for continuous surveillance and implementation of active strategies," *Brazilian J. Infect. Dis.*, vol. 23, no. 4, pp. 231–236, Jul. 2019, doi: [10.1016/j.bjid.2019.06.007](https://doi.org/10.1016/j.bjid.2019.06.007).
- [34] D. H. Huh et al., "Immunogenicity and protective efficacy of a newly developed tri-component diphtheria, tetanus, and acellular pertussis vaccine in a murine model," *J. Microbiol. Immunol. Infect.*, vol. 51, no. 6, pp. 732–739, Dec. 2018, doi: [10.1016/j.jmii.2017.04.003](https://doi.org/10.1016/j.jmii.2017.04.003).
- [35] A. Y. Aqeel, H. M. Arishi, H. I. Ageel, and N. H. Arishi, "Epidemiological and clinical aspects of neonatal tetanus from a tertiary care hospital," *Int. J. Pediatr. Adolesc. Med.*, vol. 4, no. 2, pp. 71–74, Jun. 2017, doi: [10.1016/j.ijpam.2016.10.001](https://doi.org/10.1016/j.ijpam.2016.10.001).
- [36] G. Singh et al., "The burden of neurological disorders across the states of India: the Global Burden of Disease Study 1990–2019," *Lancet Glob. Heal.*, vol. 9, no. 8, pp. e1129–e1144, Aug. 2021, doi: [10.1016/S2214-109X\(21\)00164-9](https://doi.org/10.1016/S2214-109X(21)00164-9).

- [37] P. Hanvatananukul et al., "Seroprevalence of antibodies against diphtheria, tetanus, and pertussis among healthy Thai adolescents," *Int. J. Infect. Dis.*, vol. 96, pp. 422–430, Jul. 2020, doi: [10.1016/j.ijid.2020.04.088](https://doi.org/10.1016/j.ijid.2020.04.088).
- [38] A. Strezova et al., "The adjuvanted recombinant zoster vaccine co-administered with a tetanus, diphtheria and pertussis vaccine in adults aged ≥ 50 years: A randomized trial," *Vaccine*, vol. 37, no. 39, pp. 5877–5885, Sep. 2019, doi: [10.1016/j.vaccine.2019.08.001](https://doi.org/10.1016/j.vaccine.2019.08.001).
- [39] A. Kaeding, K. Tarlock, E. A. Kolb, and S. Meshinchi, "Immunotherapeutic Targeting of Mesothelin in Acute Myeloid Leukemia in Vitro with Anetumab Ravtansine and a Novel Antibody-Drug Conjugate," *Blood*, vol. 132, pp. 1448–1448, Nov. 2018, doi: [10.1182/blood-2018-99-110845](https://doi.org/10.1182/blood-2018-99-110845).
- [40] I. Toker et al., "Tetanus immunity status among adult trauma patients in an ED," *Turkish J. Emerg. Med.*, vol. 17, no. 3, pp. 95–98, Sep. 2017, doi: [10.1016/j.tjem.2017.02.001](https://doi.org/10.1016/j.tjem.2017.02.001).
- [41] S. M. McAlister, A. H. J. van den Biggelaar, R. B. Thornton, and P. C. Richmond, "Optimising a 6-plex tetanus-diphtheria-pertussis fluorescent bead-based immunoassay," *MethodsX*, vol. 8, p. 101360, 2021, doi: [10.1016/j.mex.2021.101360](https://doi.org/10.1016/j.mex.2021.101360).
- [42] C. Leese et al., "Duplication of clostridial binding domains for enhanced macromolecular delivery into neurons," *Toxicon X*, vol. 5, p. 100019, Mar. 2020, doi: [10.1016/j.toxcx.2019.100019](https://doi.org/10.1016/j.toxcx.2019.100019).
- [43] E. H. Ibrahim et al., "TH1/TH2 chemokines/cytokines profile in rats treated with tetanus toxoid and *Euphorbia tirucalli*," *Saudi J. Biol. Sci.*, vol. 26, no. 7, pp. 1716–1723, Nov. 2019, doi: [10.1016/j.sjbs.2018.08.005](https://doi.org/10.1016/j.sjbs.2018.08.005).
- [44] F. Omeñaca et al., "Immunization of preterm infants with GSK's hexavalent combined diphtheria-tetanus-acellular pertussis-hepatitis B-inactivated poliovirus-Haemophilus influenzae type b conjugate vaccine: A review of safety and immunogenicity," *Vaccine*, vol. 36, no. 7, pp. 986–996, Feb. 2018, doi: [10.1016/j.vaccine.2018.01.005](https://doi.org/10.1016/j.vaccine.2018.01.005).
- [45] S. B. Han et al., "Immunogenicity and safety of the new reduced-dose tetanus–diphtheria vaccine in healthy Korean adolescents: A comparative active control, double-blind, randomized, multicenter phase III study," *J. Microbiol. Immunol. Infect.*, vol. 50, no. 2, pp. 207–213, Apr. 2017, doi: [10.1016/j.jmii.2015.04.005](https://doi.org/10.1016/j.jmii.2015.04.005).
- [46] A. S. De Groot et al., "Identification of a potent regulatory T cell epitope in factor V that modulates CD4+ and CD8+ memory T cell responses," *Clin. Immunol.*, vol. 224, p. 108661, Mar. 2021, doi: [10.1016/j.clim.2020.108661](https://doi.org/10.1016/j.clim.2020.108661).
- [47] P. O'Neil, A. Ladokhin, L. Swint-Kruse, and M. Baldwin, "Fluorescent Study on Tetanus Neurotoxin," *Biophys. J.*, vol. 118, no. 3, p. 359a, Feb. 2020, doi: [10.1016/j.bpj.2019.11.2066](https://doi.org/10.1016/j.bpj.2019.11.2066).
- [48] K. Bollaerts, T. Verstraeten, and C. Cohet, "Observational studies of non-specific effects of Diphtheria-Tetanus-Pertussis vaccines in low-income countries: Assessing the potential impact of study characteristics, bias and confounding through meta-regression," *Vaccine*, vol. 37, no. 1, pp. 34–40, Jan. 2017, doi: [10.1016/j.vaccine.2018.11.049](https://doi.org/10.1016/j.vaccine.2018.11.049).
- [49] A. Fettelschoss-Gabriel et al., "Treating insect-bite hypersensitivity in horses with active vaccination against IL-5," *J. Allergy Clin. Immunol.*, vol. 142, no. 4, pp. 1194–1205.e3, Oct. 2018, doi: [10.1016/j.jaci.2018.01.041](https://doi.org/10.1016/j.jaci.2018.01.041).
- [50] S. W. Mogensen, A. Andersen, A. Rodrigues, C. S. Benn, and P. Aaby, "The Introduction of Diphtheria-Tetanus-Pertussis and Oral Polio Vaccine Among Young Infants in an Urban African Community: A Natural Experiment," *EBioMedicine*, vol. 17, pp. 192–198, Mar. 2017, doi: [10.1016/j.ebiom.2017.01.041](https://doi.org/10.1016/j.ebiom.2017.01.041).