する必要があるだろう。しかし、本研究の結果から、新生児に特異的な毒性を示すことを示唆するデータが無い限りは、個人差を考慮した不確実係数 10 及び重要な情報の欠落を考慮した不確実係数 3~10 を用いることで、適切なリスクアセスメントが実施することができると考えられる。

D. 結論

(1) 水質基準・目標・要検討項目等に関する最新情報のフォローアップ: WHO の飲料水水質ガイドラインにおける最新の評価は、LOAEL の代わりにベンチマークドース (BMDL)を使用していること、動物実験の結果をヒトに外挿する際に PBPK 手法を用いて標的臓器等における化学物質濃度を補正していること、遺伝毒性発がん物質について BMDL を出発点とした直線外挿を行っていること、などが特徴的であった。食品安全委員会において清涼飲料水に係る化学物質の健康影響評価が行われている 9 物質のうち、1,1-ジクロロエチレン、ジクロロアセトニトリル及び抱水クロラールについては平成 15 年度改定時と比較して評価が大きく変わっていたものの、それ以外の 6 物質の評価法についてはほとんど違いがみられなかった。

(2) 内分泌攪乱物質や新たに健康影響等が懸念される物質の毒性情報収集: 有機スズ化合物については、生殖発生毒性および免疫毒性に関する研究は多く報告されているが、その他の一般毒性、特に長期曝露に関する情報はほとんどないことが明らかとなった。得られた情報からブチルあるいはフェニルの三および二置換体が同レベル暴露で影響を示すのに対して、モノ置換体の毒性は弱いことが示唆された。また、メチルおよびエチルなどの低級アルキル置換体は、生殖発生毒性および免疫毒性よりも神経毒性を示す傾向が高いことが示された。PBDE に関しては、毒性データは限られていたものの、多くの場合、肝重量の増加、T4 の減少、生殖発生影響が数 mg/kg 以上で認められていた。一方で、一部の同族体(BDE-47 や BDE-99:Penta-BDE の主成分)については、より低用量での胎生/新生児期暴露による影響 (精子数減少や行動異常など)が認められていることが明らかとなった。HBCD と TBBPA については比較的多くの情報を得ることが出来た。HBCD については肝臓および甲状腺への影響が報告されており、最近報告された 28 日間反復投与試験では甲状腺重量の変化をもとに BMDL は 1.6 mg/kg/day とされている。一方、TBBPA の 28 日/90 日間反復投与試験では 1,000 mg/kg/day 投与によっても明確な有害影響は観察されていない。HBCD 及び TBBPA 共に、胎児毒性/催奇形性は認められていないが、最近、神経発達への影響を示唆する変化が報告されていた。

(3) 安全性評価手法に関する研究: 日本と WHO の水道水質基準値設定手法の比較においては、TDI と VSD の算出のための一般原理は同じであるが、適用されたエンドポイントが異なることが明らかになった。さらに、基準値の算出に用いられた飲水寄与率が異なることも明らかになった。化学物質に対する新生児の感受性に関する研究では、対象とした 18 物質のうち、およそ 2/3 の物質については、新生児ラットが若齢ラットよりも明らかに高い感受性 (新生児ラットで 2 倍から最大 8 倍の感受性)を示し、残りの物質については、若齢ラットと同等の感受性、もしくは新生児ラットの方が低い感受性 (0.1 から 2 倍未満)を示すことが明らかになった。

E. 健康危険管理情報

なし

F. 研究発表

論文発表

Ema M, Fujii S, Ikka T, Matsumoto M, Hirose A, Kamata E. Early pregnancy failure induced by dibutyltin dichloride in mice. Environ Toxicol, 22, 44-52, 2007.

Ema M, Fujii S, Matsumoto M, Hirose A, Kamata E. Prenatal developmental toxicity study of basic rubber accelerator, 1,3-di-*o*-tolylguanidine, in rats. Reprod Toxicol, 22, 672-678, 2006.

Ema M, Fukui Y, Aoyama H, Fujiwara M, Fuji J, Inouye M, Iwase T, Kihara T, Oi A, Otani H, Shinomiya M, Sugioka K, Yamano T, Yamashita KH, Tanimura T. Comments from the Developmental Neurotoxicology Committee of the Japanese Teratology Society on the OECD Guideline for the Testing of Chemicals, Proposal for a New Guideline 426, Developmental Neurotoxicity Study, Draft Document (October 2006 version), and on the Draft Document of the Retrospective Performance Assessment of the Draft Test Guideline 426 on Developmental Neurotoxicity. Cong Anom (in press).

Ema M, Fukunishi K, Matsumoto M, Hirose A, Kamata E. Evaluation of Developmental Toxicity of Ultraviolet Absorber

2-(3′,5′-Di-tert-butyl-2′-hydroxyphenyl)-5-chlorobenzotriazole in Rat. Drug Chem Toxicol 29, 215-225, 2006.

Ema M, Fukunishi K, Matsumoto M, Hirose A, Kamata E, Ihara T. Developmental toxicity of dibutyltin dichloride in cynomolgus monkeys. Reprod Toxicol, 23, 12-19, 2007.

Ema M, Hara H, Matsumoto M, Hirose A, Kamata E. Evaluation of developmental toxicity of 1-butanol given to rats in drinking water throughout pregnancy. Food Chem Toxicol, 43, 325-331, 2005.

Ema, M., Harazono, A., Fujii, S. and Kawashima, K. Evaluation of developmental toxicity of ß-thuyaplicin (hinokitiol) following oral administration during organogenesis in rats. Food Chem. Toxicol., 42, 465-470, 2004.

Ema M, Hirose A. Reproductive and developmental toxicity of organotin compounds. Golub MS, Ed. Metals, Fertility, and Reproductive Toxicity, CRC Press, Boca Raton, 23-64, 2006.

Ema M, Ito Y, Matsumoto M, Hirose A, Kamata E. Combined repeated dose and reproductive/developmental toxicity study of rubber accelerator, N,N-dicyclohexyl-2-benzothiazolesulfenamide, in rats. Drug Chem Toxcicol, 30 (in press).

Ema M, Kimura E, Matsumoto M, Hirose A, Kamata E. Reproductive and developmental toxicity screening test of basic rubber accelerator, 1,3-di-*o*-tolylguanidine, in rats. Reprod Toxicol 22, 30-36, 2006.

Fukuda, N., Ito, Y., Yamaguchi, M., Mitsumori, K., Koizumi, M., Hasegawa, R., Kamata, E. and Ema, M. Unexpected nephrotoxicity induced by tetrabromobisphenol A in newborn rats. Toxicol. Lett., 150, 145-150, 2004.

Fukui Y, Ema M, Fujiwara M, Higuchi H, Inouye M, Iwase T, Kihara T, Nishimura T, Oi A, Ooshima Y, Otani H, Shinomiya M, Sugioka K, Yamano T, Yamashita KH, and Tanimura T. Comments from the Behavioral Teratology Committee of the Japanese Teratology Society on OECD Guideline for the Testing of Chemicals, Proposal for a New Guideline 426, Developmental Neurotoxicity Study, Draft Document (September 2003). Cong. Anom. (Kyoto)., 44,172-177, 2004.

Hamamura M, Hirose A, Kamata E, Katoku K, Kuwasaki E, Oshikata T, Nakahara Y, Ema M, Hasegawa R. Semi-quantitative immunohistochemical analysis of male rat-specific alpha(2u)-globulin accumulation for chemical toxicity evaluation. J Toxicol Sci., 31: 35-47, 2006.

Hasegawa R, Hirata-Koizumi M, Dourson M, Parker A, Hirose A, Kamata E, Ema M. Pediatric Susceptibility to 18 Industrial Chemicals: A Comparative Analysis with Older Experimental Animals. Regul Toxicol Pharmacol, **47**, 2006 Dec 6; Epub ahead of print PMID: 17157422.

Hasegawa R, Hirata-Koizumi, M., Takahashi M, Kamata E, Ema M. Comparative susceptibility of newborn and young rats to six industrial chemicals. Congenit Anom Kyoto, 45, 137-145, 2005.

Hasegawa R, Koizumi M, Hirose A. Principles of risk assessment for determining the safety of chemicals: Recent assessment of residual solvents in drugs and di(2-ethylhexyl) phthalate. Congenit Anom (Kyoto), 44, 51-59, 2004.

Hayashi M, Kamata E, Hirose A, Takahashi M, Morita T, Ema M. In silico assessment of chemical mutagenesis in comparison with results of Salmonella microsome assay on 909 chemicals. Mutat. Res., 588:129-135, 2005

Hirata-Koizumi, M., Hamamura M, Furukawa H, Fukuda N, Ito Y, Wako Y, Yamashita K, Takahashi M, Kamata E, Ema M, Hasegawa R. Elevated susceptibility of newborn as compared with young rats to 2-tert-butylphenol and 2,4-di-tert-butyl phenol toxicity. Congenit Anom Kyoto, 45, 146-153, 2005.

Hirata-Koizumi, M., Nishimura, N., Enami, T., Wada, H., Ogata, H., Yamamoto, Y., Ito, Y., Kamata, E., Ema, M. and Hasegawa, R. The susceptibility of new born rats to the hepatotoxicity of 1,3-dibromopropane and 1,1,2,2-tetrabromoethane, compared with young rats. J. Toxicol. Sci., 30, 29-42, 2005.

Hirose A, Hasegawa R, Nishikawa A, Takahashi M and Ema M. Revision and establishment of Japanese drinking water quality guidelines for di(2-ethylhexyl) phthalate, toluene and vinyl chloride - differences from the latest WHO guideline drafts -. J Toxicol Sci, **29**, 535-539, 2004.

Takahashi M, Hirata-Koizumi M, Nishimura N, Ito Y, Sunaga M, Fujii S, Kamata E, Hasegawa R, Ema M. Susceptibility of newborn rats to 3-ethylphenol and 4-ethylphenol compared with that in young rats. Congenit Anom Kyoto, 46: 26 -33, 2006.

Takahashi M, Ogata H, Izumi H, Yamashita K, Takechi M, Hirata-Koizumi M, Kamata E, Hasegawa R, Ema M. Comparative toxicity study of 2,4,6-trinitrophenol (picric acid) in newborn and young rats. Cong. Anom. (Kyoto). 44, 204-214, 2004.

江馬　眞. OECD の高生産量化学物質安全性点検プログラムとその手順、化学生物総合管理学会, 2, 83-103, 2006.

江馬　眞. 生殖発生毒性試験の役割、産科と婦人科 74 巻 3 号 (特集／妊娠と薬), 309-315, 2007.

高橋美加、平田睦子、松本真理子、広瀬明彦、鎌田栄一、長谷川隆一、江馬　眞、OECD 化学物質対策の動向(第 6 報)－第 14 回 OECD 高生産量化学物質初期評価会議(2002 年パリ)、化学生物総合管理学会誌、1, 46-55, 2005.

高橋美加、平田睦子、松本真理子、広瀬明彦、鎌田栄一、長谷川隆一、江馬　眞、 OECD 化学物質対策の動向(第 7 報)－第 15 回 OECD 高生産量化学物質初期評価会議(2002 年ボストン)、衛研報告、123, 46-52, 2005.

高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞、OECD 化学物質対策の動向(第 8 報)－第 16 回 OECD 高生産量化学物質初期評価会議(2003 年パリ)、化学生物総合管理学会誌, 2, 147-162, 2006.

高橋美加, 松本真理子, 川原和三, 菅野誠一郎, 菅谷芳雄, 広瀬明彦, 鎌田栄一, 江馬　眞. OECD 化学物質対策の動向 (第 9 報) －第 17 回 OECD 高生産量化学物質初期評価会議 (2003 年アローナ), 化学生物総合管理学会誌, 2, 163-175, 2006.

高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞. OECD 化学物質対策の動向 (第 10 報) －第 18 回 OECD 高生産量化学物質初期評価会議 (2004 年パリ)、化学生物総合管理学会雑誌, 2, 286-301, 2006.

高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞. OECD 化学物質対策の動向 (第 11 報) －第 19 回 OECD 高生産量化学物質初期評価会議 (2004 年ベルリン)、国立医薬品食品衛生研究所報告、124, 62-68, 2006.

広瀬明彦、江馬　眞. 生殖発生毒性を指標としたダイオキシンの耐容 1 日摂取量(TDI)算定の考え方について、国立医薬品食品衛生研究所報告 **122**: 56-61, 2004.

松本真理子、川原和三、菅谷芳雄、江馬　眞. OECD 高生産量化学物質点検プログラム：第 21 回初期評価会議概要, 化学生物総合管理学会誌, 2, 135-146, 2006.

松本真理子、鈴木理子、川原和三、菅谷芳雄、江馬　眞、OECD 高生産量化学物質点検プログラム:第 20 回初期評価会議概要, 化学生物総合管理学会誌 1, 445-453, 2005.

松本真理子、高橋美加、平田睦子、広瀬明彦、鎌田栄一、長谷川隆一、江馬　眞、OECD 高生産量化学物質点検プログラム:第 18 回初期評価会議までの概要、化学生物総合管理学会誌, 2, 104-135, 2006.

松本真理子、田中里依、川原和三、菅谷芳雄、江馬　眞、 OECD 高生産量化学物質点検プログラム:第 19 回初期評価会議概要, 化学生物総合管理学会誌 1, 280-288, 2005.

松本真理子、日下部哲也、川原和三、菅谷芳雄、江馬　眞. OECD 高生産量化学物質点検プログラム：第 22 回初期評価会議概要, 化学生物総合管理学会誌, 2, 302-312, 2006.

学会発表

Ema M. Introduction of Division of Risk Assessment. NIHS/NCBSR-KFDA/NITR Workshop on Regulatory Science and Information in Toxicological Evaluation of Potential High Risk Materials. November 29, 2006, Mita Conference Center.

Ema M. OECD high production volume chemicals programmeory NIHS/NCBSR-KFDA/NITR Workshop on Regulatory Science and Information in Toxicological Evaluation of Potential High Risk Materials. November 29, 2006, Mita Conference Center.

Ema M, Arima A, Fukunishi K, Matsumoto M, Hirose A, Kamata E, Ihara T. Prenatal developmental toxicity of dibutyltin in cynomolgus monkeys given on consecutive three days during organogenesis. EUROTOX 2006 (9/20-24, Dubrovnik/Cavtat) 9/22, 2006.

Ema M, Fujii S, Ikka T, Matsumoto M, Hirose A, Kamata E. Pre- and post implantation embryonic loss induced by dibutyltin given to mice during early pregnancy. The 26th International Symposium on Halogenated Environmental Organic Pollutants and POPs (DIOXIN 2006, Oslo, 8/21-25, 8/24), 2006.

Ema M, Fujii S, Matsumoto M, Hirose A, Kamata E. Teratogenic effects of rubber accelerator, 1,3-di-o-tolylguanidine (DTG), in rats. 27th Annual meeting of American College of Toxicology (10/5-8, Palm Springs), 2006.

Ema M, Fukunishi K, Matsumoto M , Hirose A, Kamata E. "Developmental toxicity study of ultraviolet light absorber 2-(3,5-di-*tert*-butyl-2-hydroxyphenyl)-5-chloro-2H-benzotriazole in rats." 25th Annual Meeting of The American College of Toxicology, Palmsprings CA U.S.A, November 7-10, 2004.

Ema M, Fukunishi K, Matsumoto M, Hirose A, Kamata E, Arima A, Ihara T. Teratology study of dibutyltin in cynomolgus monkeys given during organogenesis. The 45th Annual Meeting of the Society of Toxicology, San Diego, 2006.

Ema M, Hara H, Matsumoto M, Hirose A, Kamata E. Developmental neurotoxicity of polysorbate 80 in rats. International Conference on Food Contamination and Neurodevelopmental Disorders (12/3-5, 2006, Malmo), 2006

Ema M, Matsumoto M, Takahashi M, Hirata-Koizumi M, Hirose A, Kamata E, Hasegawa R, Yamamoto N. The Contribution of the Japanese Government to the OECD High Production Volume Chemicals Programme: Summary of 1st to 21st SIDS Initial Assessment Meetings. Fist U.S.Conference on Charactering Chemicals in Commerce: Using Data on High Production Volume (HPV) Chemicals. (12/12-14, 2006. Radisson Inn,Austin, Texas)

Ema M, Matsuyama T, Matsumoto M, Hirose A, Hirata-Koizumi M, Kamata, E. Toxicity study of ultraviolet light absorber 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole (DBHCB) in rats during the pre-weaning period. The 46th Annual Meeting of the Society of Toxicology, 2007.

Ema M, Kimura E, Hirose A, Kamata E. Reproductive and developmental toxicity screening test of 1,3-di-o-tolylguanidine in rats. EUROTOX 2005.

Fukunishi K, Hirose A, Matsumoto M, Hirata-Koizumu M, Kamato E, Ema M. Combined repeated dose toxicity with the reproductive/developmental toxicity screening test of ultraviolet absorber 2-(3,5-di-tert-butyl-2-hydroxyphenyl)-5-chloro-2H-benzotiazole (DBHCB) in rats. The 46th Annual Meeting of the Society of Toxicology, 2007.

Hasegawa R, Hirata-Koizumi M, Dourson M, Hirose A, Nakai S, Kamata E and Ema M. 43rd Congress of European Societies of Toxicology, September Dubrovnik/Cavtat, Croatia "Comprehensive Evaluation of Pediatric Susceptibility to 18 Industrial Chemicals", 2006.

Hasegawa R, Hirata-Koizumi M, Takahashi M, Kamata E, Ema M . Susceptibility of newborn rats to six chemicals, compared to young rats. 42nd Congress of European Societies of Toxicology, Cracow, Poland. September, 2005.

Hirose A, Aisaki K, Hara H, Takahashi M, Igarashi K, Kanno J, Ema M. DNA Micro-Array Analysis of Gene Expressions in Mice Uterus Exposed with Dibutyltin Chloride during Implantation. The 25th International Symposium on Halogenated Environmental Organic Pollutants and POPs (DIOXIN 2005). Toronto, Canada, Aug, 2005.

Hirose A, Aisaki H, Oh K, Matsumoto M, Kamata E, Igarashi K, Kanno J, Ema M. Gene Expression s analysis in uterus and ovary of mice treated dibutyltin dichloride during implantation. The 26th International Symposium on Halogenated Environmental Organic Pollutants and POPs (DIOXIN 2006, Oslo, 8/24), 2006.

Hirose A, Kamata E, Akiyama H, Takahashi M, Ema M, Hayashi M. Development in silico genotoxicity predictory system on chromosomal aberration for existing chemicals. EUROTOX 2006 (9/20-24, Dubrovnik/Cavtat) 9/21, 2006.

Hirose A, Kanno J, Tokunaga H, Nakazawa K, Honma M, Inoue T. Initial investigation on the assessment of nanomaterial safety by the Japanese MHLW. 2nd International Symposium on Nanotechnology and Ocupational Health, Minneapolis, USA, Oct.

2005.

Hirose A, Takagi A, Nishimura T, Kanno J, Ema M. "Review of reproductive and developmental toxicity induced by organotins in aquatic organisms and experimental animals." 24th International Symposium on Halogenated Environmental Organic Pollutants and POPs. Berlin, September 6-10, 2004

Hirose A, Yamazoe Y, Ema M, Kawamura Y. Toxicity testing schema for the initial risk assessment of food contact plastics based on the concept of ttc and usage probabilistic factors. The 46th Annual Meeting of the Society of Toxicology, 2007.

Nishimura T, Tahara M, Kubota R, Shimizu M, Ema M, Tokunaga H.. Behavior of fenthion after chlorination treatment and effect of its products on cholinesterase activity. The 45th Annual Meeting of the Society of Toxicology, San Diego, 2006.

江馬 眞、OECD 発生神経毒性試験ガイドラインについて、第 17 回神経行動毒性研究会、2005.

江馬 眞、OECD 神経発生毒性試験ガイドライン 426(ドラフト)の進捗状況、第 45 回日本先天異常学会学術集会 BT シンポジウム、2005.

江馬 眞. 生殖毒性、第 7 回日本トキシコロジー学会生涯教育講習会 (名古屋、7/3), 2006.

江馬 眞、原 洋明、松本真理子、広瀬明彦、鎌田栄一、ブタノールのラットにおける発生毒性の検討、第 45 回日本先天異常学会学術集会、2005.

江馬 眞、福西克弘、松本真理子、広瀬明彦、鎌田栄一、紫外線吸収剤 2-(3,5-di-tert-butyl-2-hydroxyphenyl)-5-chlorobenzotriazole のラットにおける発生毒性、第 32 回日本トキシコロジー学会学術年会、2005.

江馬 眞、福西克弘、松本真理子、広瀬明彦、鎌田栄一、伊原敏夫. カニクイザルにおけるジブチルスズの発生毒性試験、第 46 回日本先天異常学会学術集会 (山形、6/29-30), 2006.

江馬 眞、藤井咲子、松本真理子、広瀬明彦、鎌田栄一. 加硫促進剤 1,3-di-o-tolylguanidine のラットにおける出生前発生毒性、第 33 回日本トキシコロジー学会学術年会 (名古屋、7/5), 2006.

江馬 眞、藤井咲子、松本真理子、広瀬明彦、鎌田栄一、有機スズ化合物の生殖発生毒性:ジブチルスズのマウスにおける胚致死作用、第 7回環境ホルモン学会研究会、2005.

江馬 眞、松山隆史、松本真理子、広瀬明彦、鎌田栄一. 紫外線吸収剤 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole のラット新生児における毒性、第 46 回日本先天異常学会学術集会 (山形、6/29-30), 2006.

長谷川隆一. 第 33 回日本トキシコロジー学会学術年会, 名古屋 "新生児動物における毒性感受性", 2006.

平田睦子、楠岡 修、西村信雄、和田 肇、緒方英博、福田苗美、伊藤義彦、鎌田栄一、江馬 眞、長谷川隆一、化学物質に対する新生児の感受性に関する研究:1,3-ジブロモプロパン及び 1,1,2,2-テトラブロモエタン、第 32 回日本トキシコロジー学会学術年会、2005.

広瀬明彦、鎌田栄一、高橋美加、江馬 眞 "有機スズの水生動物と実験動物における生殖発生毒性" 環境ホルモン学会第 7 回研究発表会, 名古屋、12 月 14-15 日、2004.

G. 知的財産権の出願・登録状況(予定を含む)

1. 特許取得

(該当なし)

2. 実用新案登録

(該当なし)

3. その他

(該当なし)

研究成果の刊行に関する一覧表

書籍

著者氏名	論文タイトル名	書籍全体の編集者名	書籍名	出版社名	出版地	出版年	ページ
J.Fawell K.Bailey J.Chilton E.Dahi L.Fewtrell Y.Magara	Fluoride in Drinking-water	World Health Organization	WHO Drinking-water Quality Series	IWA	LONDON	2006	134
遠藤卓郎	Ⅲ.物 15. 健康関連微生物 15.4 原虫・寄生虫 15.4.1 種類と性状	（社）日本水環境学会	水環境ハンドブック	朝倉書店	東京	2006	453-457
遠藤卓郎 黒木俊郎	第6章　生物的因子と健康	大沢基保 内海英雄	環境衛生科学	南江堂	東京	2006	159-184
遠藤卓郎 泉山信司	2章 原虫 3章 細菌 6章 緊急時の対応	金子義光	水道の病原微生物対策	丸善(株)	東京	2006	9-70 158-163 239-247
国包章一	新しい凝集剤の利用	(財)水道技術研究センター	新しい浄水技術	技法堂出版	東京	2005	9-13
国包章一	水環境の視点から水道のあり方を考える	「自然と共生した流域圏・都市の再生」ワークショップ実行委員会	自然と共生した流域圏・都市の再生	山海堂	東京	2005	103-110
国包章一	水の安全管理	森澤眞輔	生活水資源の循環技術	コロナ社	東京	2005	152-215
国包章一		金子義光	水道の病原微生物対策(一部分担執筆)	丸善(株)	東京	2006	70-90
国包章一		日本陸水学会	陸水の事典(一部分担執筆)	講談社	東京	2006	

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Ohno, K., Kadota, E., Kondo, Y., Kamei, T., and Magara, Y.	Estimation of geographical variation of cancer risks in drinking water in Japan	Water Science & Technology : Water Supply	6(2)	31-37	2006

T.Ohgai, Y.Oguchi, K.Ohno, T.Kamei, Y.Magara and M.Itoh	Development of evaluation methods to introduce a nanofiltration membrane process in drinking water treatment	Water Science & Technology : Water Supply	6(2)	9-17	2006
眞柄泰基	水道原水を考慮した浄水処理	資源環境対策	42(13)	50-54	2006
Ogawa Y., Kawamura Y., Wakui C., Mutsuga M., Nishimura T. and Tanamoto, K.	Estrogenic activities of chemicals related to food contact plastics and rubbers tested by the yeast two-hybrid assay	Food Additives and Contaminants	23(4)	422-430	2006
Tetsuji Okuda, Wataru Nishijima, Mitsumasa Okada	Assimilable Organic Carbon (AOC) Originated From Picophytoplankton in Drinking Water	Water Science & Technology : Water Supply	6(2)	169-176	2006
J.Kim, S.Lee, S.Xu, M.Akiba, M.Nomura, N.Chiba, K.Nakano, and O.Nishimura	Assimilable organic carbon formation from algogenic organic matter and its variation by chlorination	Water Science & Technology : Water Supply	6(2)	239-244	2006
秋葉道宏、国包章一	水道水における利水障害の発生状況とその対策	水環境学会誌	28(5)	296-300	2005
Nishimura T., Iizuka S., Kibune N., Ando M. And Magara Y.,	Study of 1,4-Dioxane intake inthe Total Diet	Journal of Health Science	51(4)	514-517	2005
金　志勲、許　春蓮、秋葉道宏、宮川徹也、千葉信男、西村　修、西村哲治、安藤正典	水道原水における同化性有機炭素の動態に関する基礎的研究	水道協会雑誌	73(11)	11-18	2005
Umemura T., Kitamura Y., Kanki K., Maruyama S., Okazaki K., Imazawa T., Nishimura T., Hasegawa R., Nishikawa A. and Hirose M.	Dose-related changes of oxidative stress and cell proliferation in kidneys of male and female F344 rats exposed to potassium bromate	Cancer Sci.	95(5)	393-398	2004
Nishimura T., Iizuka S., KIbune N. and Ando M.	Study of 1.4-Dioxane intake in the Total Diet Using the Market-Basket Method	J. Health Sci.	50(1)	101-107	2004

Izumi T., Yagita K., Endo T., Ohyama T.	Detection System of *Cryptosporidium parvum* Oocysts by Brackish Water Benthic Shellfish (*Corbicula japonica*) as a Biological Indicator in River Water.	Arch. Envion. Contam Toxicol.	51	559-566	2006
Matsushita, T., Le-Clech, P., Chen, V. and Wickramasinghe, S.R.	Behavior of gold colloid as model viruses during filtration through adsorptive ion exchange membranes	*Desalination*	199(1-3)	105-107	2006
Matsushita, T., Matsui, Y. and Shirasaki, N.	Analyzing mass balance of viruses in a coagulation-ceramic microfiltration hybrid system by a combination of the polymerase chain reaction (PCR) method and the plaque forming units (PFU) method	*Water Science and Technology*,	53(7)	199-207	2006
Izumi T., Itoh Y., Yagira K., Endo T., Ohyama T.	Brackish Water Benthic Shellfish (*Corbicula Japonica*) as a Biological Indicator for *Cryptosporidium parvum* Oocysts in Ricer Water	Bull. Environ. Contam. Toxicol.	72	29-37	2004
Endo t., Morishima Y.	Major helminth zoonoses in water	Waterborne Zoonoses Identification, Causes, and Control (WHO)		291-304	2004
Kosaka K., Asami M., Matsuoka Y., Kamoshita M., and Kunikane S	Occcurrence of perchlrorate in drinking water sources of metropolitan area in Japan	Water Research(投稿中)			
浅見真理	水の安全管理	チャイルドヘルス	18(7)	29-32	2005
越後信哉、伊藤禎彦、夏井智毅	染色体異常誘発性からみた浄水プロセスにおけるオゾン/塩素処理の評価	環境工学研究論文集	43	599-604	2006
越後信哉、伊藤禎彦、荒木俊明、安藤良	臭化物イオン共存下での塩素処理水の安全性評価：祐樹臭素化合物の寄与率	環境工学研究論文集	41	279-289	2004

Echigo S., Itoh S., Natsui T., Araki T., abd Ando R	Contribution of brominated organic disinfection by-products to the mutagenicity of drinking water	Water Sci.Technol.	5(5)	321-328	2004
Kuwahara M., Miura M., Niwa A., Echigo S., and Itoh S	Bromide Removal by Hydrotalcite-like Compounda	Advances in Asian Environmental Engineering	5(1)	47-52	2006
越後信哉、ロジャー マイニーア	浄水プロセスにおけるNOMおよびフェノール性化合物の臭素化反応の速度論	環境システム制御学会誌	10(2)	44-52	2005
浅見真理	水道水の成分と検査	チャイルドヘルス	8(7)	22-27	2005
Kosaka K., Asami M., Matsuoka Y., Kamoshita M., and Kunikane S	Occurrence of perchlorate at water treatment plans of the River Basin in Japan	233rd American Chemical Society(Acs) National meeting（発表予定）			
小坂浩司、浅見真理、松岡雪子、鴨志田公洋、国包章一	利根川流域の水道における過塩素酸イオンの実態調査	第41回日本水環境学会年会講演集(発表予定)			
鴨志田公洋、小坂浩司、浅見真理、松岡雪子	イオン交換カラムを用いたLC/MSによる過塩素酸イオン測定法の開発	第41回日本水環境学会年会講演集(発表予定)			
小坂浩司、浅見真理、松岡雪子、鴨志田公洋、国包章一	IC/MS/MSを用いた利根川流域の過塩素酸イオンの実態調査	環境システム計測制御学会誌	11(2, 3)	215-218	2006
浅見真理、小坂浩司、松岡雪子、鴨志田公洋	IC/MS/MS法を用いた環境水及び水道水中のハロゲン酸分析法と過塩素酸の検出	第9回日本水環境学会シンポジウム講演集		54-55	2006
大谷真巳、林田武志、高橋俊介、松岡雪子、浅見真理	水道用次亜塩素酸ナトリウム中の臭素酸に関する調査	全国水道研究発表講演集		590-591	2006
Asami M., Kosaka K., Kunikane S	Bromate, Chlorate, Chlorite and Perchlorate in Sodium Hypochlorite Used in Water Supply	ASPIRE（投稿中）			

Echigo S., Itoh S., Miyagawa Y., and Tanida S	Source water quality management for controlling disinfection by-products	Proceedings of JSPS-VCC Conference of Environmental Ethics and Sustainability			2006
Ken T., Muto T., Yanagibashi Y., Itoh S., Echigo S., Ohkouchi Y. and Jinno H	Exposure assessment of trihalomethans in households for estimating allocation to drinking water	Proceedings of the 15th Joint KKNN Symposium on Environmental Engineering		269-276	2006
Yano Y., Echigo S. and Itoh S.	Screening of chemical structures related to haloacetic acid formation in drinking water chlorination process	Proceedings of IWA World Water Congress and Exhibition			2006
柳橋泰生、権大維、武藤輝生、神野透人、伊藤禎彦、越後信哉、大河内由美子	トリハロメタン類の飲用寄与率推定のため室内曝露量評価	第57回全国水道研究発表会講演集		682-683	2006
宮川幸雄、谷田慎也、越後信哉、伊藤禎彦	琵琶湖・淀川水系における臭化物イオンの発生構造	第57回全国水道研究発表会講演集		556-557	2006
越後信哉、伊藤禎彦、丹羽明彦、笹山航、桑原昌紘	イオン交換法による臭化物イオンの選択的除去	環境衛生工学研究	20(3)	23-26	2006
桑原昌紘、越後信哉、伊藤禎彦	イオン交換法による臭化物イオンの制御	第40回日本水環境学会年会講演集		23	2006
島崎大、相澤貴子、西村哲治、安藤正典、国包章一、眞柄泰基	水道水源水および浄水における臭素酸イオンの実態調査	第55回全国水道研究発表会講演集		618-619	
Echigo S., Itoh T., Araki Y., Miyagawa Y. and ando R.	Importance of Controlling brominated disinfection by-products in drinking water Treatment	International Workshop on Water Mangement Systems for Creating Healthy Water Environment		43-52	2005

Shimazaki D., Asami M., Nishimura T., Aizawa T., Kunikane S. and Magara Y.	Occurrence of bromate in raw and finished waters for drinking water supply in Japan	Proc. 13th Japan/Korea symposium on water environment 2004		89-95	2004
矢野雄一、越後信哉、伊藤禎彦	浄水塩素処理過程におけるハロ酢酸生成に関わる化学構造のスクリーニング	第42回環境工学研究フォーラム講演集		150-152	2005
Matsui, Y., Narita, K., Inoue, T. and Matsushita	Screening level analysis for monitoring pesticide in river water using a hydrological diffuse pollution model with limited input data	*Water Sci. & Tech*	**53**(10)	173-181	2006
Matsui, Y., Narita, K., Inoue, T. and Matsushita, T	Investigation rice-farming pesticide concentrations in river water using a basin-scale runoff model with uncertain inputs	*Transactions of the ASABE*	**49**(6)	1723-1735	2006
Tahara, M., Kubota, R., Nakazawa, H., Tokunaga, H. and Nishimura	Analysis of active oxon forms of nine organophosphorus pesticides in water samples using gas chromatography with mass spectrometric detection	*J. Health Science*	**52**(3)	313-319	2006
池貝隆宏	流域の環境負荷評価のための農薬流出推定	環境情報科学論文集	**20**	31-36	2006
Matsui Y., Narita K., Inoue T. and Matsushita T	Precise Data Sets on Farming and Pesticide Properties Verify a diffuse Pollution Hydrological Model for Predicting Pesticide Concentration	10th Specialized Conference on Diffuse Pollution and Sustainable Basin Management			2006
鴨志田公洋, 小坂浩司, 浅見真理, 相澤貴子	塩素処理における有機りん系農薬の類型別反応性とオキソン体への変換について	*水環境学会誌*（掲載予定）			

Kunikane, S	Application of "Water safety Plan" to drinking water quality management in Japan.	Proceedings of the Japan-U.S Gavernmental Conference on Drinking Water Quality Management and Wastewater Control,			Okinawa January 2007
Matsui Y., Matsushita T., Yamada M. and Sumigawa Y.	Effect of uncertainties in agricultural working schedules and Monte-Carlo evaluation of model input in vasin-scale runoff model analysis of herbicieds	Water Science & Technology	51(3-4)	329-337	2005
Tahara M., Kubota R., Nakazawa H., Tokunaga H., Nishimura T.	Use of cholinesterase activity as an indicator for the effects of combinations of organophosphorus pesticides in water from environmental sources	Water Research	39	5112-5118	2005
Ayano E., Okada Y., Sakamoto C., Kanazawa H., Okano T., Ando M., Nishimura T.	Analysis of herbicides in water using temperature-responsive chromatography and an aqueous mobile phase	Journal of Chromatography A	1069	281-285	2005
嶋津治希、杉田育生、橋渡健児、米倉祐司、高尾健一郎、広田忠彦	太田川流域の浄水場における農薬類検出実験と原水中濃度の予測	水道協会雑誌	74(1)	19-27	2005
荒井崇子、鎌田素之、島崎　大、浅見真理、相澤貴子	農薬の分子構造別の塩素分解性に関する研究	水環境学会誌	28(7)	437-444	2005
相澤貴子、嶋田俊夫、鎌田素之、西村哲治	水道における新たな農薬監視体制	用水と排水	46(7)	582-590	2004
服部晋也、田中航也、小椋淳二、塩出貞光	浄水場原水実態調査結果に基づく適切な農薬監視項目の選定について	大阪市水道局水質試験所調査研究ならびに試験成績	56	29-35	2004

Ayano E., Kanazawa H., Ando Ml., Nishimura T.	Determination and quantitation of sulfonylurea and urea herbicides in water samples using liquid chromatography with electrospray ionization mass spectrometric detection	Analytica Chimica Acta	507	211-218	2004
Ema M, Fujii S, Ikka T, Matsumoto M, Hirose A, Kamata E	Early pregnancy failure induced by dibutyltin dichloride in mice	Environ Toxicol	22	44-52	2007
Ema M, Fujii S, Matsumoto M, Hirose A, Kamata E	Prenatal developmental toxicity study of basic rubber accelerator, 1,3-di-*o*-tolylguanidine, in rats	Reprod Toxicol	22	672-678	2006
Ema M, Fukui Y, Aoyama H, Fujiwara M, Fuji J, Inouye M, Iwase T, Kihara T, Oi A, Otani H, Shinomiya M, Sugioka K, Yamano T, Yamashita KH, Tanimura T	Comments from the Developmental Neurotoxicology Committee of the Japanese Teratology Society on the OECD Guideline for the Testing of Chemicals, Proposal for a New Guideline 426, Developmental Neurotoxicity Study, Draft Document (October 2006 version), and on the Draft Document of the Retrospective Performance Assessment of the Draft Test Guideline 426 on Developmental Neurotoxicity	Cong Anom (in press)			
Ema M, Fukunishi K, Matsumoto M, Hirose A, Kamata E.	Evaluation of Developmental Toxicity of Ultraviolet Absorber 2-(3′,5′-Di-tert-butyl-2′- hydroxyphenyl)-5-chlorobenzotriazole in Rat. Drug	Chem Toxicol	29	215-225	2006
Ema M, Fukunishi K, Matsumoto M, Hirose A, Kamata E, Ihara T	Developmental toxicity of dibutyltin dichloride in cynomolgus monkeys	Reprod Toxicol	23	12-19	2007

Ema M, Ito Y, Matsumoto M, Hirose A, Kamata E	Combined repeated dose and reproductive/developmental toxicity study of rubber accelerator, N,N-dicyclohexyl-2- benzothiazolesulfenamide, in rats	Drug Chem Toxcicol	30 (in press)		
Ema M., Hara H., Matsumoto M., Hirose A., Kamata E.	Evaluation of developmental toxicity of 1-butanol given to rats in drinking water throughout preganancy	Food and Chemical Tpxicology	43	325-331	2005
Ema M., Harazono A., Fijii S., Kawashima K.	Evaluation of developmental toxicity of β-thujaplicin(hinokitiol) following oral administration during organogenesis in rats	Food and Chemical Tosicology	42	465-470	2004
Ema M., Hirose A.	Reproductive and developmental toxicity of organotin compounds	Golub MS.Ed. Metals, Fertility, and Reproductive Toxicity CRC Press, Boca Raton		23-64	2006
Ema M., Kimura E., Matsumoto M., Hirose A., Kamata E.	Reproductive and developmental toxicity screening test of basic rubber accelerator, 1,3-di-*o*-tolylguanidine, in rats	Reprod Tpxicol	22	30-36	2006
Fukuda, N., Ito, Y., Yamaguchi, M., Mitsumori, K., Koizumi, M., Hasegawa, R., Kamata, E. and Ema, M.	Unexpected nephrotoxicity induced by tetrabromobisphenol A in newborn rats.	Toxicol. Lett.	150	145-155	2004
Fukui Y, Ema M, Fujiwara M, Higuchi H, Inouye M, Iwase T, Kihara T, Nishimura T, Oi A, Ooshima Y, Otani H, Shinomiya M, Sugioka K, Yamano T, Yamashita KH, and Tanimura T.	Comments from the Behavioral Teratology Committee of the Japanese Teratology Society on OECD Guideline for the Testing of Chemicals, Proposal for a New Guideline 426, Developmental Neurotoxicity Study, Draft Document (September 2003)	Cong. Anom. (Kyoto)	44	172-177	2004

Hamamura M, Hirose A, Kamata E, Katoku K, Kuwasaki E, Oshikata T, Nakahara Y, Ema M, Hasegawa R.	Semi-quantitative immunohistochemical analysis of male rat-specific alpha(2u)-globulin accumulation for chemical toxicity evaluation.	J Toxicol Sci.	31	35-47	2006
Hasegawa r., Hirata-Koizumi M., Dourson M., Parker A., Hirose A., Kamata E., Ena M.	Pediatric Susceptibility to 18 Industrial Chemicals: A Comparative Analysis with Older Experimental Animals	Regul Toxicol Pharmacol	47	Epub ahead of print PMID :17157422	2006 Dec 6
Hasegawa R, Hirata-Koizumi, M., Takahashi M, Kamata E, Ema M.	Comparative susceptibility of newborn and young rats to six industrial chemicals	Congenit Anom	44	51-59	2004
Hasegawa R, Koizumi M, Hirose A	Principles of risk assessment for determining the safety of chemicals: Recent assessment of residual solvents in drugs and di(2-ethylhexyl) phthalate	Congenit Anom (Kyoto),	44	51-59	2004
Hayashi M, Kamata E, Hirose A, Takahashi M, Morita T, Ema M.	In silico assessment of chemical mutagenesis in comparison with results of Salmonella microsome assay on 909 chemicals	Mutat. Res.	588	129-135	2005
Hirata-Koizumi, M., Hamamura M, Furukawa H, Fukuda N, Ito Y, Wako Y, Yamashita K, Takahashi M, Kamata E, Ema M, Hasegawa R.	Elevated susceptibility of newborn as compared with young rats to 2-tert-butylphenol and 2,4-di-tert-butyl phenol toxicity.	Congenit Anom	45	146-153	2005
Hirata-Koizumi, M., Nishimura, N., Enami, T., Wada, H., Ogata, H., Yamamoto, Y., Ito, Y., Kamata, E., Ema, M. and Hasegawa, R.	Susceptibility of new born rats to the hepatotoxicity of 1,3-dibromopropane and 1,1,2,2-tetrabromoethane, compared with young rats.	J. Rozixol.Sci.	30(1)	29-42	2005

Hirose A, Hasegawa R, Nishikawa A, Takahashi M and Ema M.	Revision and establishment of Japanese drinking water quality guidelines for di(2-ethylhexyl) phthalate, toluene and vinyl chloride - differences from the latest WHO guideline drafts -.	J. Toxicol. Sci.	29(5)	535-539	2004
Takahashi M, Hirata-Koizumi M, Nishimura N, Ito Y, Sunaga M, Fujii S, Kamata E, Hasegawa R, Ema M.	Susceptibility of newborn rats to 3-ethylphenol and 4-ethylphenol compared with that in young rats.	Congenit Anom	46	26-33	2006
Takahashi M, Ogata H, Izumi H, Yamashita K, Takechi M, Hirata-Koizumi M, Kamata E, Hasegawa R, Ema M.	Comparative toxicity study of 2,4,6-trinitrophenol (picric acid) in newborn and young rats	Cong. Anom.	44	204-214	2004
江馬　眞	OECDの高生産量化学物質安全性点検プログラムとその手順	化学生物総合管理学会誌	2(1)	83-103	2006
江馬　眞	生殖発生毒性試験の役割	産科と婦人科	74(3) 特集・妊娠と薬	309-315	2007
高橋美加、平田睦子、松本真理子、広瀬明彦、鎌田栄一、長谷川隆一、江馬　眞	OECD化学物質対策の動向(第6報)－第14回OECD高生産量化学物質初期評価会議(2002年パリ)	化学生物総合管理学会誌	1(1)	46-55	2005
高橋美加、平田睦子、松本真理子、広瀬明彦、鎌田栄一、長谷川隆一、江馬　眞	OECD化学物質対策の動向(第7報)－第15回OECD高生産量化学物質初期評価会議(2002年ボストン)	衛研報告	123	46-52	2005
高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞	OECD化学物質対策の動向(第8報)－第16回OECD高生産量化学物質初期評価会議(2003年パリ)	化学生物総合管理学会誌	2(1)	147-162	2006
高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞	OECD化学物質対策の動向（第9報）－第17回OECD高生産量化学物質初期評価会議（2003年アローナ）	化学生物総合管理学会誌	2	163-175	2006
高橋美加、松本真理子、川原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞	OECD化学物質対策の動向（第10報）－第18回OECD高生産量化学物質初期評価会議（2004年パリ）	化学生物総合管理学会誌	2	286-301	2006

高橋美加、松本真理子、河原和三、菅野誠一郎、菅谷芳雄、広瀬明彦、鎌田栄一、江馬　眞	OECD化学物質対策の動向(第11報)—第19回OECD高生産量化学物質初期評価会議（2004ベルリン)	国立医薬品食品衛生研究所報告	124	62-68	2006
広瀬明彦、江馬　眞	生殖発生毒性を指標としたダイオキシンの耐容1日摂取量(ＴＤＩ)算定の考え方について	国立医薬品食品衛生研究所報告	122	56-61	2004
松本真理子、日下部哲也、川原和三、菅谷芳雄、江馬　眞	OECD高生産量化学物質点検プログラム：第22回初期評価会議概要	化学生物総合管理学会誌	2	302-312	2006
松本真理子、川原和三、菅谷芳雄、江馬　眞	OECD高生産量化学物質点検プログラム：第２１回初期評価会議概要	化学生物総合管理学会誌	2	135-146	2006
松本真理子、鈴木理子、川原和三、菅谷芳雄、江馬 眞、	OECD高生産量化学物質点検プログラム:第20回初期評価会議概要	化学生物総合管理学会誌	1(3)	445-453	2005
松本真理子、田中里依、川原和三、菅谷芳雄、江馬 眞	OECD高生産量化学物質点検プログラム:第19回初期評価会議概要	化学生物総合管理学会誌	1(2)	280-288	2005
松本真理子、高橋美加、平田睦子、広瀬明彦、鎌田栄一、長谷川隆一、江馬 眞	OECD高生産量化学物質点検プログラム:第18回初期評価会議までの概要	化学生物総合管理学会誌	2(1)	104-134	2006

研究成果の刊行物・別刷

Estimation of geographical variation of cancer risks in drinking water in Japan

K. Ohno, E. Kadota, Y. Kondo, T. Kamei and Y. Magara

Department of Socio-Environmental Engineering, Hokkaido University, N13W8, Kita-ku, Sapporo, 060-8628, Japan (E-mail: *ohnok@eng.hokudai.ac.jp*)

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Abstract The cancer risks posed by ten substances in raw and purified water were estimated for each municipality in Japan to compare risks between raw and purified water, and inter-municipality. Water concentrations were estimated by use of statistical data. Assigning cancer unit risks to each substance and applying the assumption of additive toxicological effects to multiple carcinogens, total cancer risks of the waters were estimated. As a result, the geometric means of total cancer risks in raw and purified water were 1.16×10^{-5} and 2.18×10^{-5}, respectively. In raw water, the contribution ratio of arsenic to total cancer risk accounted for 97%. In purified water, that of four trihalomethanes (THMs) accounted for 54%. The increase of total cancer risks in purified water was due to THMs. In regard to the geographical variation, the relationship between population size and total cancer risks were investigated. The result was that there were higher cancer risks in the big cities with the population more than a million both in raw and purified water. One plausible reason for the higher risks in purified water in the big cities is a larger chlorination dose due to the huge water supply areas. The reason for the increase in raw water remained unclear.

Keywords Arsenic; cancer risk; drinking water; geographical variation; trihalomethane; water purification

Introduction

Drinking water quality issues, especially the issues on adverse health effects, have been one of the great concerns both of water works and water consumers. Although statistical data on drinking water quality have been provided by Japan Water Works Association (JWWA) for a long time, the data are merely a number of concentrations of substances, and thus it is very difficult for people to understand. Recently, Geographical Information System (GIS) has been widely applied as one of the new tools for visualization and spatial analyses. Integration of statistical water quality data and GIS may clarify the geographical characteristics of raw and purified water quality.

In this study, we focus on the carcinogenic substances in drinking water in Japan. Ten carcinogenic substances were selected for evaluation and the concentrations of these substances both in raw and purified water were estimated by the municipality unit. Applying the oral cancer unit risk for each substance and the assumption of additive toxicological effects to multiple carcinogens, total cancer risks of the waters were estimated by the municipality unit, and nationwide maps regarding the total cancer risks in raw and purified water were drawn with GIS. Furthermore, the characteristics and geographical variation of cancer risks were analyzed by use of drawn maps and statistical methods. The differences in substances contributing to the total cancer risks between raw and purified water, and the relationship between population size and total cancer risks were discussed.

Methods

Selection of target substances and assignment of their cancer unit risks

Chemical substances for the estimation of cancer risks were selected based on the following conditions. First, the substances that were in the Japanese Drinking Water Quality

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Standard of 2001 were chosen. Although the new Standard was amended in 2004, statistical water quality data for 2004 were not yet available. Therefore, carcinogenic substances such as haloacetic acids and bromate, which were newly introduced in the Standard, were not included in this study. Second condition was that the substances should be carcinogenic or suspected to be carcinogenic. Third was that the substances should have oral unit risks as carcinogen in the Integrated Risk Information System (IRIS) by the United States Environmental Protection Agency (US-EPA). Consequently, ten substances were chosen for the analysis in this study. The names of the substances and oral unit risks assigned in this study, and Standard Values of Japanese Drinking Water Quality as of 2001 are shown in Table 1.

The term 'oral unit risk' is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 mg/L in water (US-EPA, 2005) and expressed as the probability of developing tumors. The unit risks used in this study were mainly quoted from IRIS database (US-EPA, 2005). The unit risks of several substances were presented as several discrete values or a range of values. In this case, the geometric mean (*G*-mean) of the several unit risks or that of the maximum and the minimum values was used. The unit risk of chloroform is an exception. The oral unit risk of chloroform is not applicable in IRIS as of 2005 because EPA relies on a nonlinear dose-response approach and the use of margin-of-exposure analysis for cancer risk, for chloroform is not expected to produce rodent tumors via a mutagenic mode of action (US-EPA, 2005). Nonetheless, it was considered to be very useful to estimate and compare the extent of cancer risks of chloroform as one of trihalomethanes (THMs). Therefore, the unit risk of 1.8×10^{-4} (per mg/L) for chloroform, which had formerly been applied by IRIS, was used in this study. It should be noted that the quantitative cancer risk of chloroform might cause the overestimation of total cancer risk in this study.

Procedures to estimate the total cancer risks by the municipality unit

Concentrations of target substances in raw and purified water in each water purification plant. Statistics on water supply ("*Suidou Toukei*" in Japanese) were used as water quality and quantity database. The statistics have been edited by JWWA every year and consist of the data of water utilities which have more than 5000 design population served. Therefore, data of the smaller water utilities are not included in the statistics and were omitted in this study.

The statistics published in 2003 (JWWA, 2003), which describe the data of the fiscal year 2001, were mainly used in this study. The statistics include the data on

Table 1 Substances and oral unit risks assigned in this study, and Standard Values of Japanese Drinking Water Quality (2001)

Substances (CAS No.)	Oral unit risks assigned in this study (per mg/L)	Standard Values of Japanese Drinking Water Quality as of 2001 (mg/L)
1,2-Dichloroethane (107-06-2)	2.6×10^{-3}	0.004
1,3-Dichloropropene (542-75-6)	1.8×10^{-3}	0.002
Dichloromethane (75-09-2)	2.1×10^{-4}	0.02
Arsenic, inorganic (7440-38-2)	5×10^{-2}	0.01
Benzene (71-43-2)	8.4×10^{-4}	0.01
Carbon tetrachloride (56-23-5)	3.7×10^{-3}	0.002
Chloroform (67-66-3)	1.8×10^{-4}	0.06
Bromodichloromethane (75-27-4)	1.8×10^{-3}	0.03
Dibromochloromethane (124-48-1)	2.4×10^{-3}	0.1
Bromoform (75-25-2)	2.3×10^{-4}	0.09