I have seen an official record of the result of a serological test for the animal, carried out on a sample taken on (dd/mm/yy)_____and tested in an approved laboratory, which states that the rabies-neutralizing antibody titre was equal to or greater than 0.5 IU/ml.

Name, date and signature of the authorized veterinarian:

本動物の血清検査結果の公式記録により，(日 / 月 / 年) _____ に採取された検体について公認検査機関で行われた検査において，本件動物の狂犬病の抗体は 0.5 IU/ml 以上であることを確認した。

認定獣医師の氏名，日付，署名：

Tests supplémentaires ／ Further tests ／追加検査：

Date	Résultat	Laboratoire agréé	Signature et cachet du vétérinaire
	Result	Approved laboratory	Signature and stamp of veterinary surgeon
日付	結果	公認検査機関	獣医師署名・証印

V. Autres vaccinations ／ Other vaccinations ／その他のワクチン接種

Date	Vaccin utilisé	Numéro de lot	Signature et cachet du vétérinaire
	Type of vaccine	Batch no.	Signature and stamp of veterinary surgeon
日付	ワクチンの種類	ロット番号	獣医師署名・証印

VI. Informations complémentaires ／ Additional information ／追加情報

Pays d'origine ／ Country of origin ／出身国

_____

Pays dans lesquels l'animal a séjourné, selon les déclarations du propriétaire (indiquer les dates)
Countries visited by the animalas declared by the owner (give dates)
本動物の飼い主は，本動物について以下の国への渡航歴があることを申告する（渡航日を記載する）

_____

_____

_____

_____

_____

_____

Notes ／注

Le présent certificat ne dispense pas de l'application des autres dispositions en vigueur pour l'entrée dans chaque pays. Prière de lire la section VII.

This certificate may not be sufficient to meet all the requirements of the countries of destination. Please read Section VII.

この証明書は，渡航先の入国必要条件を満たさない場合がある。VII 項を参照すること。

Autorisation d'imprimer délivrée par (indiquer l'autorité national compétente) :
Printing authorized by (indicate the national responsible authority) :
記載事項承認機関：

Pour être valable, le présent certificat doit porter un numéro perforé à chaque page.

To be valid, this certificate must bear a number perforated on each page.

各頁に通し番号の記載がない証明書は無効である。

VII. Passage de frontière ／ Frontier crossing ／海外渡航

1. Le propriétaire de l'animal doit, avant de se rendre à l'étranger avec celui-ci, s'assurer des conditions sanitaires imposées par les autorités du pays de destination, le présent certificat ne dispensant pas de l'application des autres dispositions en vigueur dans certains pays.

   The owner of the animal must, before going abroad with it, make sure of the veterinary requirements laid down by the authorities of the country of destination, as this certificate may not be sufficient to meet all the requirements of the country of destination.

   この証明書は，渡航先の入国必要条件を満たさない場合があるため，動物の飼い主は，当該動物を伴って海外へ渡航する際は，事前に渡航先当局が課す獣医学上の基準を確認すること。

2. Le présent certificat est valable à partir du trentième jour et jusqu'à la fin du douzième mois après la date de la première vaccination ; dans le cas d'une revaccination au cours de la période de validité, pendant les douze mois qui suivent la date de revaccination.

   This certificate is valid from the 30th day until the end of the 12th month after the date of the first vaccination; in the case of revaccination within the validity period, for 12 months from the date of revaccination.

   この証明書は，初回ワクチン接種日より起算して，第 30 日目から第 12 ヵ月最終日まで有効とする。有効期限内に再接種を受けた場合は，再接種から 12 ヵ月間有効とする。

3. Le présent certificat doit être imprimé et complété en Français et en Anglais, et si nécessaire, dans la langue du pays d'origine.

   This certificate must be printed and completed in French and English and, if necessary, the language of the country of origin.

   この証明書はフランス語ならびに英語，および必要であれば出身国の言語で記入する。

補遺5 ――ヒト狂犬病曝露歴書式(例)

以下の記録書式は土台であり，適宜変更してもよい。

ヒト狂犬病曝露歴書式(例)

症例 No._____　　紹介者_____

咬傷を受けた者

名　前_____　　咬傷を受けた日 _____

年　齢_____　　咬傷事故発生の場所 _____

自宅住所 _____　　咬傷を受けた場所_____

_____　　咬傷の性質_____

☐1ヵ所　☐2ヵ所以上

☐軽　度　☐中等度　☐重　度

その他同じ動物の咬傷を受けた被害者（該当者がいる場合）（その氏名と住所）

1._____

2._____

3._____

4._____

治　療

被害者の処置内容_____

ワクチン

ワクチンの種類(脳由来／細胞培養)

_____

製造者およびロット番号 _____

_____

接種経路 _____

接種量 _____

接種日_____

_____

_____

_____

これまで狂犬病ワクチン接種を受けたことがありますか？_____

投与日 _____

種　類 _____

免疫グロブリン

狂犬病免疫グロブリン (RIG) の原料

☐ヒト　☐動物

製造者およびロット番号 _____

_____

投与薬剤_____

過敏反応検査結果_____

投与日_____

これまで狂犬病免疫グロブリン投与を受けたことがありますか？ _____

投与日 _____

種　類 _____

接種後・投与後に有害反応はありましたか。あった場合は，処置内容，副作用の性質，転機を詳記してください。＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

曝露から6ヵ月後の被害者の状態

☐ 生　　存
☐ 狂犬病により死亡　　死亡日＿＿＿＿＿＿＿＿＿＿＿＿
☐ ほかの原因で死亡
☐ 不　　明

同一の動物により咬傷を受けた被害者の容態（判明している場合）：＿＿＿＿＿＿＿＿＿＿＿＿
＿＿

加害動物

動物種＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
品　種＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿　年　齢＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
性　別＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿　体　重＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
当該動物は狂犬病ワクチン接種していましたか。＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿
「はい」の場合，ワクチンの種類＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿　接種日＿＿＿＿＿＿＿＿

転　　機

☐ 観察中　　☐ 安楽死　　☐ 逃　走

＿＿＿＿日後の結果　＿＿＿＿＿＿＿＿　実験室内検査の結果　＿＿＿＿＿＿＿＿

☐ 狂犬病の兆候あり
☐ 健康体
☐ 死　亡

	陽性	陰性
蛍光抗体検査	☐	☐
ネグリ小体	☐	☐
動物接種試験	☐	☐
その他の検査	☐	☐

補遺6 ———RABNET: ヒトおよび動物狂犬病のための双方向型情報マッピングシステム

http://www.who.int/rabies/rabnet

WHOは1959年以来，加盟国を対象に世界狂犬病調査（World Rabies Survey，WRS）を実施し，ヒト狂犬病と動物狂犬病に関するデータの収集に努めてきました。1990年代後半に入り，それまで郵便（船便，航空郵便）で行われていた調査方法にインターネットが加わるようになり，この2年間でさらなる改善がはかられました。その結果，このたび「RABNET 2」にバージョンアップされる運びとなりました。

RABNET 2は，世界全体または国別の狂犬病発生地図をインタラクティブに作成できるなどの新機能を備えています。近い将来には，地方さらには地域社会別にこうした地図を作成できるようになる予定です。また既成の地図，狂犬病関連文書，世界各国のWHO狂犬病協力センター一覧なども見ることができます。またRABNET 2の狂犬病データからさまざまな国別指標（人口，教育・保健サービス）などにリンクが張られ，特定の国の各レベルにおける狂犬病の状況がどうなっているのか，より総合的に見渡せるようになっています。

この新しいシステムでは，オンラインでアンケート調査データへのアクセスや入力が可能となりました。狂犬病の指標となる項目が見直され，その結果，質問数は少なくなっています。データは入力後に自動的に“RABNET 2”に送信され，すぐに情報へのアクセス・利用が可能となりました。

オンラインアンケートにアクセスするためには，ユーザー名とパスワードが必要です。なお，RABNETデータバンクやその他の機能へのアクセスは無料です。

問い合わせ先：rabnet@who.int

研究成果の刊行に関する一覧表

書籍

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丸山総一	犬・猫の感染症と寄生虫病（翻訳）		小動物臨床のための5分間コンサルタント診断治療ｶﾞｲﾄﾞ	インターズー	東京	2007	117-202
赤尾信明	医動物学	芝紀代子	臨床検査技師グリーン・ノート臨床編	メディカルビュー	東京	2007	62-71

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Naohide Takayama	Rabies: a preventable but incurable disease	J Infect Chemother	14	8-14	2008
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Sugita S, Shimizu N, Kawaguchi T, Akao N, Morio T, Mochizuki M.	Identification of human herpesvirus 6 variant A in a patient with ocular toxocariasis. Archives of Ophthalmology.	Arch Ophthalmol	125	1426-1427	2007
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原　著

国産狂犬病ワクチンの皮内接種によるヒトへの狂犬病曝露前免疫の検討

Yanagisawa Naoki 柳澤　如樹[1)]　Takayama Naohide 高山　直秀[2)]　Suganuma Akihiko 菅沼　明彦[1)]

目　的

2006年11月に国内で相次いで輸入狂犬病患者が発生した後[1,2)]，狂犬病ワクチンの需要が急増した．しかし，需要の増加が供給を上回っていたため，全国的に狂犬病ワクチンが品不足に陥った．このため，厚生労働省は緊急避難的に狂犬病曝露前免疫を制限する方針を示した．世界保健機関(WHO)は，狂犬病流行地において動物による咬傷を受けた場合，抗狂犬病免疫グロブリン(RIG)の投与と組織培養不活化ワクチン接種による曝露後発症予防を勧告している[3)]．ただし，曝露前免疫を受けていればRIGの投与が不要になる．RIGは世界的に不足しており，入手が容易でないため，曝露後免疫の効果を確実にする上で，狂犬病曝露前免疫を行っておくことが重要である．わが国における狂犬病ワクチンの生産量は少なく，急な増産ができないことを鑑みれば，今回のようなワクチン不足の事態に備えて，接種ワクチン量が少なくとも，高い効果を上げることができる接種法を検討しておくことが必要である．

狂犬病常在地であるタイでは，1人当たりの狂犬病ワクチン接種量を減量するために，皮内接種法(タイ赤十字方式)が広く用いられ，曝露後発症予防に効果を上げているばかりか[4)]，曝露前免疫にも採用され成果を上げている．国産の狂犬病ワクチンを用いての皮内接種法については，高山らの皮内・皮下併用法以外に，その有効性や安全性がこれまで検討されておらず[5,6)]，皮内接種のみによる曝露前免疫は1例が報告されているにすぎない[7)]．

われわれは，国産ワクチンを用いた皮内接種法の可否を知るため，同意を得た健康成人に対して，国産狂犬病ワクチンを皮内接種して，狂犬病曝露前免疫の効果と安全性を調査した．

対象と方法

1．対　象

本調査の目的，調査項目，接種ワクチンと予測される副反応について文書，および口頭で説明をして，同意が得られた医療・獣医療関係者17例を対象とした．

2．接種ワクチン

化学及血清療法研究所(化血研)製組織培養不活化狂犬病ワクチンのロットRB02およびRB03を用いた．狂犬病ワクチンは溶解液1 mLで溶解した後，その0.1 mLずつを左右前腕に皮内注射した．

3．局所および全身反応

全例について，皮内接種15分後の接種局所における膨疹，発赤を視診で確認し，瘙痒感の有無を質問した．さらに，次回接種時および採血時に前回注射による局所の腫脹，発赤，疼痛，瘙痒感の自覚症状の有無について問診した．

4．抗体検査

狂犬病ワクチンを2～4週間隔で2回皮内接種し，2回目接種2～3週間後に採血して，血中抗狂犬病抗体価を測定した．血中抗狂犬病抗体価は，化血研臨床検査センターに依頼して，Platelia® rabies kit(BIO-RAD Laboratories)を用いてELISA法で測定した．

1）東京都立駒込病院感染症科　2）東京都立駒込病院小児科

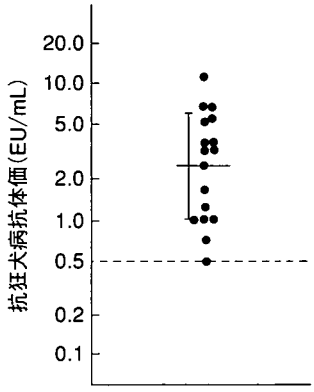

図1　被験者の抗狂犬病抗体価の分布

国産狂犬病ワクチン0.1mLを左右前腕に2～4週間隔で2回皮内接種した．2～3週間後の抗狂犬病抗体価(●)をELISA法で測定した．

横棒は幾何平均値，横棒を貫く縦棒は±SDを示す(n＝17)．

横点線はWHOの定める発症防御レベルを示す．

結　　果

1．対象者の年齢分布

対象者は男性11例，女性6例の合計17例であった．年齢分布は22歳から55歳まで，20歳代が13例，30歳代が2例，40歳代が1例，50歳代が1例であり，平均年齢は30.2±7.5歳であった．

2．血中抗狂犬病抗体価

ワクチンを2回皮内接種した2～3週間後には，17例全例で，抗体価が0.5 EU/mL以上に上昇していた．抗体価の範囲は0.5～11.5 EU/mL，幾何平均値は2.5 EU/mLであった(図1)．

3．接種後の局所反応および全身症状

ワクチン接種15分後，局所の発赤を呈した者は5例，腫脹を認めた者は9例，疼痛を認めた者は0例，瘙痒感を認めた者は2例であった．局所の発赤は，数日間残ったと報告した者があったが，発熱，頭痛，倦怠感などの全身症状を報告した例はなかった．

考　　察

本邦での狂犬病曝露前免疫は，組織培養不活化ワクチン1回量1.0 mLを4週間隔で2回，その後6～12カ月後に1回皮下注射する方式が標準である[8]．しかし，今回生じたようなワクチン供給不足の状況において，1人に1回量1.0 mLを投与すれば，短期間にワクチンが枯渇して，実際上狂犬病ワクチン接種が不可能となるであろう．高山らは，狂犬病ワクチン成分にアレルギー反応がある患者に皮内接種で曝露前免疫を行った例を報告している[7]．本報告では，患者に全身反応はなく，有意な抗体上昇がみられ，国産ワクチンを用いても皮内接種による曝露前免疫が可能であることが示唆された．

今回われわれは，ワクチン不足の状況下でも，できる限り多くの人々からの要望に応えられるように，狂犬病ワクチンの1回接種量を減量しても効果が得られる方法として，タイ赤十字方式を改変した皮内接種法(駒込方式)を考案し，その有効性と安全性を検討した．小規模な接種試験であったが，接種者全員の抗体価が0.5 EU/mL 以上となった．これはWHOの定める発症防御レベルの0.5 IU/mL以上と同等とみなすことができる．また，接種部位の発赤など軽度の局所副反応を認めたが，全身的副反応は認められなかった．

わが国における狂犬病ワクチンの生産量は，定期接種のワクチンに比べれば非常に少なく，急激な需要の増大が起これば，狂犬病ワクチンが不足する事態は避けられない．ワクチン不足への対処法として，ワクチンの備蓄や外国から緊急輸入などの方策が考えられる．しかし，ワクチンの備蓄は期限切れで廃棄することになる可能性や，外国産のワクチンの輸入に関しては法的な制限もあり，現実的には難しい．また，ワクチンは急に増産することができない．交通手段の発達により，日本から数時間以内で狂犬病常在地に渡航できることを考えると，今後も輸入狂犬病患者が発生し，再び狂犬病ワクチンの供給不足が発生する可能性があることを十分認識する必要がある．

今回検討した駒込方式は，接種量が少なくとも，標準法に劣らず効果がみられ，かつ副反応も軽微であるため，ワクチン不足時にはもちろん，平時にも使用できる有効な曝露前免疫法となる可能性があり，今後はより多くの被接種者を対象として，さらなる検討を行う価値がある．

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文　　献

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Pre-Exposure Prophylaxis for Rabies with Intradermal Injection Using Japanese Rabies Vaccine

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In November 2006, two consecutive imported rabies cases were reported in Japan. The demand for rabies vaccine has grown rapidly, resulting in a shortage of the vaccine. Therefore, pre-exposure prophylaxis for rabies was restricted. In order to prepare for the vaccine shortage, it is necessary to consider a method that is effective yet uses less amount of the vaccine. The intradermal method we tested uses only 20% of the vaccine dose required under the standard method, but every subject tested had a sufficient rise in their anti-rabies antibody titer. This was a small inoculation trial, but intradermal vaccination is an effective method, and may be used on a regular basis not only when vaccine is short.

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REVIEW ARTICLE

Naohide Takayama

Rabies: a preventable but incurable disease

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Abstract Rabies is a typical zoonotic disease which has been known for more than 4300 years. To date, no effective medical therapy has been established for overt rabies. The rabies post-exposure prophylaxis (PEP), which is a serial vaccination against rabies starting as soon as possible after the patient was bitten by a suspected rabid animal, is the only way to prevent death. In Japan, no rabies case has been reported for about 50 years. However, rabies is epizootic in many Asian countries, where more than 50% of the rabies deaths in the world occur. The Japanese travelers who visit these countries every year may not be aware of this fact since no rabies occurs in their own country. Therefore, the risk of being bitten by a rabid animal abroad and developing rabies after returning to Japan seems to be high. All medical staff should keep in mind that imported rabies cases can occur at any time. In addition, pre-exposure vaccination against rabies should be recommended to international travelers in order to ensure the preventative effect of PEP.

Key words Rabies · Vaccine · Post-exposure prophylaxis · Pre-exposure immunization · Lyssavirus · Hydrophobia

Introduction

Half a century has passed since rabies was eradicated in Japan. However, in November 2006, two cases of imported rabies occurred,[1,2] reminding us that rabies is not a disease which only existed in the past. From a world-wide point of view, countries that are free from rabies are the exception, and there are still many areas in the world where rabies continues to occur.[3] However, in regions where rabies is endemic, there are some areas where many patients die from rabies, and other areas where it rarely occurs. In Asian countries, hundreds or thousands of patients are killed by rabies every year. Considering the fact that the number of Japanese people traveling to Asian countries has recently increased, imported rabies cases are much more likely to occur than an invasion of rabid animals into Japan from these areas.

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Clinical features of rabies

Rabies is mainly a disease occurring in animals, and it is regarded as one of the most typical zoonoses. Rabies is known to have the following features.

(1) The incubation period of rabies is generally very long, ranging from 1 to 3 months (about 60% of cases) to more than 1 year (6%–7% of cases) (pathogenetic features).

(2) Almost 100% of patients who develop clinical rabies die, because the rabies virus causes fatal encephalomyelitis and no effective treatment has yet been developed. There are no laboratory tests to determine whether a person is infected with the rabies virus during the incubation period (clinical features).

(3) The host animals of the rabies virus differ among regions, even though almost every mammal is capable of contracting rabies. The main vectors are foxes in Europe and Canada, raccoons, skunks, and fruit-eating and insectivorous bats in the United States, dogs in Asia, mongooses, jackals, and dogs in Africa, and dogs and vampire bats in Latin America. There are two types of epizootic rabies, namely the urban type and the sylvatic type. The former type is where the rabies virus is principally transmitted among dogs, and the latter type is where the vectors are the wildlife, such as foxes, raccoons, and mongooses (epidemiological features).

Rabies is caused by the rabies virus, which is an enveloped, bullet-shaped, size 75 nm in diameter and 100–300 nm in length, single-stranded, minus-sense RNA virus.[3,4] It belongs to the genus *Lyssavirus* of the family *Rhabdoviridae*. Genus *Lyssavirus* includes some antigenically rabies-related viruses (rabies-related lyssaviruses). Most of these

are transmitted among bats, and some are reported to cause clinical rabies in humans. Genus *Lyssavirus* containing rabies virus is phylogenetically divided into two groups, phylogroups I and II. The former includes the rabies virus, Duvenhage virus, European bat virus types 1 and 2, and Australian bat virus; the latter includes Lagos bat virus and Mokola virus.[3,5]

History of rabies in Japan

It is not known for sure when rabies appeared in human society. It is presumed that man began living with dogs about 30000 years ago, so there is a possibility that human rabies has occurred since then. The oldest document mentioning rabies as a zoonosis is the law enacted around 2300 BC in Mesopotamia.[6] The law, the Eshunna Code, imposed a penalty on the owner of the dog when a bitten victim died from rabies. From this description, it is understood that the causal relationship had been clearly recognized; the person bitten by a rabid dog would have overt rabies and eventually die. Humans and dogs were increasing in number, and people started moving to new regions with their dogs. This movement seems to be the reason why rabies spread to various regions around the world.[7]

In Japan, a large epizootic of rabies was documented in Nagasaki Prefecture in 1732, and had spread to Oita Prefecture the following year.[8] Expanding along the main roads to Sanyodo and Tokaido, it eventually reached Edo in 1736, when Yoshimune Tokugawa was governing as the 8th Shogun. During this epizootic, many dogs, horses, foxes, raccoon dogs, etc. were killed. In 1736, Genjo Noro (1692–1761), one of the medical officials of the Tokugawa Shogunate, published *Kyoken-kosho-chiho*, which is the first textbook on the therapy for rabies.[9] In this book, he reported that the sickness would become serious after a certain period of time, and eventually 8 or 9 out of every 10 patients would die, even if the wound did not initially appear to be severe. Furthermore, he also wrote that the best first-aid treatment was to suck out the blood as quickly as possible and to apply moxa cautery to the wound. This textbook was republished in 1756, probably because the epizootic of rabies had not ceased.

Little information is available on epizootics of rabies in the latter part of the Edo Era. We can only assume that outbreaks of rabies occurred sporadically in those days based on the statistics of the number of rabid dogs during the Meiji Era (from 1868 to 1912), when 50–200 were recorded annually.

In 1895, an epizootic of rabies occurred in Nagasaki Prefecture. During this outbreak, Tomei Kurimoto, Chief Physician of Internal Medicine at the National Nagasaki Hospital, gave a rabies vaccination to people who were bitten by rabid dogs for the first time in Japan. He made an attenuated rabies vaccine by himself, following the method of the French scientist Louis Pasteur. He injected this vaccine into 25 patients who had been bitten by dogs, and as a result none of them died.[8]

Table 1. Numbers of rabid animals reported, regions where rabid animals occurred, and people bitten by rabid animals from 1911 to 1915 in Japan (from [10], with permission)

Year	No. of rabid animals	No. of regions	No. of people bitten
1911	570	10	904
1912	719	14	953
1913	856	18	1313
1914	1383	20	2602
1915	1424	24	3230

In the latter part of the Meiji Era, outbreaks of rabies gradually increased both in number and in scale. More and more outbreaks were reported in the Taisho Era (from 1912 to 1926), mainly in large cities (Table 1). Umeno and Doi, of the Kitasato Institute for Infectious Diseases, performed a mass rabies vaccination of dogs in Kanagawa Prefecture and Tokyo Prefecture in 1918 and 1919, respectively.[10] As a result, the numbers of both rabid dogs and people bitten by such dogs decreased significantly in both regions. However, both these numbers kept increasing outside of these regions. Owing to the widespread confusion after the great Kanto earthquake in 1923, reports of rabid dogs and human rabies cases exceeded 3000 and 100 per year, respectively, in the following 2 years. From that time, standard rabies control methods, such as compulsory vaccination of all family dogs and the elimination of stray dogs, were enforced all over Japan. Consequently, the number of rabid animals steadily decreased, reaching 15 or fewer during 1934–1943.[11–13]

However, the number began to increase again due to the social disorder after World War II. Seventy-six cases of human rabies and over 800 animal rabies cases had been reported in 1949 and 1950, respectively,[12,13] which led to the Rabies Prevention Law, enacted in 1950 (Fig. 1). This law requires owners to register, confine their dogs, and make sure that a rabies vaccination is administered. It was strictly enforced, in conjunction with the elimination of stray dogs.[13] The number of rabid animals decreased rapidly, and no rabies cases in either animals or humans have been reported since 1957, except for three cases of imported human rabies in 1970 and 2006.

In Japan, epizootics of rabies have historically been of the urban type, where the rabies virus was transmitted among dogs, and occasionally from dogs to humans, cats, or other domestic and wild animals. During such epizootics, foxes and raccoon dogs were also infected with the rabies virus. No transmitting circle of the virus has formed among the wildlife in Japan.

Epidemiology of human rabies

Japan was successful in eliminating rabies, although countries free from rabies are rather an exception worldwide and there are still many endemic areas. The numbers of human rabies cases differ within these areas, ranging from areas where hundreds or thousands of people die every year to regions where human rabies is very rare. The animals trans-

mitting rabies also differ among regions, so in order to diagnose and prevent rabies it is important that we understand the epidemiology of the disease.

There are no accurate statistical data of rabies deaths in every country. The number of human rabies cases is estimated to be 55000 per year worldwide, with 56% and 44% occurring in Asia and Africa, respectively.[3] It is believed that 84% of rabies cases break out in rural and poor regions. However, the numbers of rabies deaths do not correlate with the risk of contracting rabies, because it is possible to prevent a patient from dying of rabies by giving them post-exposure prophylaxis (PEP), even after they have been bitten by a rabid animal. Without PEP, the total number of human rabies deaths in Asia and Africa combined is estimated to be about 330000.[3]

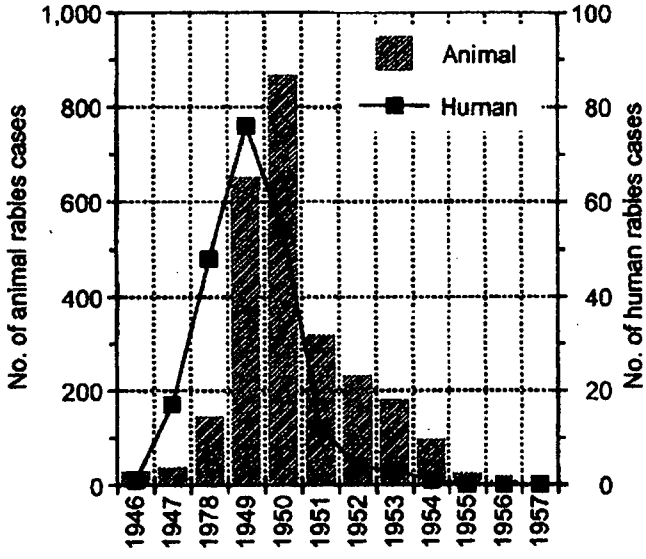

Fig. 1. Number of rabies cases reported in humans and animals in Japan after World War II. Just before World War II, the annual number of rabid animals reported was 15 or fewer because of the compulsory vaccination of family dogs and the elimination of stray dogs. However, rabies cases began to increase due to the social disorder after World War II, leading to 76 cases of human rabies in 1949 and more than 800 cases of animal rabies in 1950. In 1950, the Rabies Prevention Act was enacted. This requires dog owners to register and confine their dogs, and to vaccinate their dogs against rabies. This Act also strictly enforces the elimination of stray dogs. As a result, the number of rabid animals decreased rapidly, and no rabies case has been reported since 1957 in either humans or animals except for three imported human rabies cases. (The last human case was reported in 1954, and six rabid dogs were reported in 1956.)

In Asia, 95% of rabies is transmitted by dogs, whereas 3% is from cats. In the United States, foxes, skunks, and racoons are the host animals. In Latin America, dogs are the host animals of rabies. In addition to terrestrial animals, some species of bat transmit rabies in North and South America. In the United States, 17 out of 19 patients who contracted rabies domestically during 2000–2006 were infected by bats.[14] In cases of bat bites, it is assumed that patients often miss out on the opportunity to receive PEP because bite wounds from bats are too small to be noticed.[15]

Infection route of rabies

Humans usually contract rabies through bite wounds from rabid animals (bite exposure) because the rabies virus is highly concentrated in the saliva of infected animals. It can also be transmitted through nonbite exposure, although this rarely occurs. Airborne infections, such as inhaling an aerosol of infected animal brain tissue in virus laboratories, or of contaminated air in bat-inhabited caves, have been reported.[16–19] There is also one known case where a butcher became infected by skinning a cow that had died of an undiagnosed neurological disease.[20] Iatrogenic rabies cases have occurred in patients who received cornea, kidney, liver, or blood vessel graft transplantation from donors who had undiagnosed rabies (Table 2). To date, the only medically verified cases of human-to-human rabies transmission are the cases infected through organ transplantation from undiagnosed rabies patients.[21–29]

Table 2. Human rabies cases through organ transplantation

Case	Country	Year	Organ	Incubation period	Clinical diagnosis of donor	Reference number
1	USA	1979	Cornea	30 days	GBS	21
2	France	1980	Cornea	33 days	Encephalitis, myocarditis	22
3	Thailand	1981	Cornea	22 days	Not diagnosed	23
4	Thailand	1981	Cornea	31 days	Not diagnosed	23
5	India	1987	Cornea	2 days	Not described	24
6	India	1987	Cornea	257 days	Not described	24
7	Iran	1994	Cornea	26 days	Food poisoning	25
8	Iran	1994	Cornea	40 days	Food poisoning	25
9	USA	2004	Liver	20 days	SAH	26–28
10	USA	2004	Kidney	26 days	SAH	26–28
11	USA	2004	Kidney	26 days	SAH	26–28
12	USA	2004	Arterial fragment	25 days	SAH	26–28
13	Germany	2005	Lung	Not described	Not described	29
14	Germany	2005	Kidney	Not described	Not described	29
15	Germany	2005	Kiney/pancreas	Not described	Not described	29

GBS, Guillain–Barré syndrome; SAH, subarachnoid hemorrhage

Rabies through organ transplantation

In 1978, a 37-year-old American woman received a right corneal transplant from a 39-year-old lumberman who was presumed to have died from Guillain–Barre syndrome. Thirty days after the operation, she complained of right retro-orbital headache. In a few days, she noticed hypoesthesia on the right side of her face and difficulty in walking, and symptoms of dysphagia and dysarthria developed. After admission to hospital, she developed flaccid paralysis, became progressively obtunded, and eventually died on day 16 of hospitalization. A postmortem examination revealed rabies virus in the cornea, optic nerve, temporal lobe, and brain stem.[21]

In 1980, a 36-year-old man received a left corneal transplant from a 57-year-old woman who had died from encephalitis and myocarditis in France. Thirty-three days after the operation, he complained of left retro-orbital headache. Over the next 4 days he developed hypersalivation, pain and weakness in the legs, and pain on swallowing, and was hospitalized 41 days after the operation. He became comatose on day 3 of hospitalization and died on day 9. Rabies virus was isolated from the patient's brain tissue, and on histopathological examination numerous Negri bodies were found in the donor's brain.[22]

In 1981, a 41-year-old Thai woman received a corneal transplant from a boy who had died from an undiagnosed disease with mental confusion. A 25-year-old man also had a cornea transplant from the same donor. These recipients died 22 and 31 days after the operation, respectively. Rabies virus was isolated from the woman's brain tissue, and Negri bodies were found in the donor's brain tissue.[23]

In 1987, two Indian men received corneal grafts from a single donor. Nine days later, one of these recipients, a 62-year-old physician, reported redness, swelling, and intense pain in the operated eye. He died 14 days after the operation. The other recipient, a 48-year-old man, was advised to receive PEP. He received the first and second doses of rabies vaccine, but refused to take the remaining doses. He experienced dysphagia along with pain, redness, and swelling in the operated eye 257 days after the operation. Two days later, he developed hydrophobia. He died 5 days after the onset of the disease. The incubation period of the second man was more than 250 days, probably because he had received two doses of rabies vaccine.[24]

In 1994, a 40-year-old man received a corneal transplant from a 20-year-old man who had died from food poisoning in Iran. On the same day, another 35-year-old man received a cornea transplant from the same donor. The first patient reported nausea and paresthesia on his lips, and developed hydrophobia 26 days after the operation. He died within the next 24 h. The second patient was admitted to hospital with vomiting and poor general condition 40 days after the operation. He died the following day. Rabies virus was isolated from the brain tissue.[25]

In the United States, kidneys, liver, and an arterial segment were transplanted into four recipients from a common donor in 2004. All four recipients developed encephalitis within 30 days after transplantation, and died from rabies 7–23 days after the onset of neurological symptoms.[26–28]

In Germany, there was an announcement on February 16, 2005, that three out of six patients who had received organ transplantations from a common donor might have clinical rabies. The donor died after cardiac arrest and brain death in late 2004. Rabies was diagnosed in the donor and two of the recipients on the same day as the announcement and the next day, respectively.[29]

These cases indicate that organ transplants should not be carried out from donors who had died from encephalitis of unknown cause. At the same time, they also show that rabies is very difficult to diagnose intravitam.

Clinical course of human rabies

The clinical course of human rabies is divided into four phases: the incubation period, the prodromal phase, the acute neurological phase, and the coma phase.[30]

The incubation period for rabies varies from around 15 days to 1 year or even longer. In about 60% of all rabies patients, the incubation period is 1–3 months, but 6%–7% of patients exhibited an incubation period longer than 1 year. The longest incubation period reported was 7 years, and was documented for a girl who migrated from Laos to the United States.[31] She had been bitten by a stray dog in Laos 7 years before the onset of clinical rabies. In general, the incubation period is shorter when the bite is to the head rather than the extremities, and is also shorter in children than in adults. During the incubation period, the rabies virus propagates in the muscle cells around the port of entry and invades the peripheral nervous system. It then migrates centrally to the central nervous system, following the flow within the axoplasm of peripheral nerves at a velocity of 8–20 mm per day.[4] The symptoms of rabies first appear after the virus enters the central nervous system (prodromal phase).

In the prodromal phase, which lasts for 2–10 days, the patients complain of nonspecific symptoms such as malaise, fever, and anorexia. They may also complain of more specific local symptoms such as itchiness, pain, and paresthesia around the healed bite wound.

The acute neurological phase continues for 2–7 days. During this phase, patients will intermittently suffer from intense anxiety, emotional agitation, and confusion. At other times they may be calm, lucid, and cooperative toward the medical staff. About 60% of patients will develop severe pharyngeal and laryngeal muscle spasms when they attempt to drink, or even see, water (hydrophobia). Similar symptoms may also be induced when cool air blows on the face or chest (aerophobia). As a result, patients avoid drinking water, washing their hands, or feeling wind. The patient's condition gradually deteriorates. High fever, confusion, disorientation, paralysis, and general convulsions may occur, and the patient eventually falls into a coma.

In the coma phase, autonomic instability becomes extremely predominant, and hypotension, arrhythmia, and hypoventilation may develop. Most patients die shortly

after the onset of coma if no intensive supportive care is given.

No effective therapies for overt rabies have been established, so almost 100% of patients are destined to die. As of August 2007, there have been only six reports of patients recovering from overt rabies.[3]

Clinical and laboratory diagnosis of human rabies

A clinical diagnosis might be possible if the patient could describe the animal which had bitten them and in which rabies endemic area, and also if they showed typical symptoms such as hydrophobia or aerophobia. However, it is rarely possible to diagnose rabies clinically in Japan because the patient's history of animal bites is uncertain in most cases, and very few Japanese physicians have experienced clinical rabies.

An intravitam diagnosis of rabies could be made either by isolating the virus from saliva or cerebrospinal fluid, demonstrating a viral antigen in skin biopsy samples or corneal impression samples using the fluorescent antibody method, or detecting viral genes by reverse polymerase chain reaction (RT–PCR).[3,32] However, these laboratory methods are only useful after the virus has propagated into the brain tissue or disseminated to other parts of the body. They are not useful in the early stage of the disease, so it is practically impossible to diagnose rabies shortly after the onset.

Treatment of rabies patients

No medical treatment for clinical rabies has been established. Treatment is mainly aimed at minimizing the clinical signs and symptoms, and especially at reducing physical and psychological pain. Patients should be cared for in a private room with sufficient sedation. The intravenous administration of morphine is effective to relieve anxiety, agitation, hydrophobia, and aerophobia. Life-support measures should be avoided after rabies has been confirmed.[3] One case was reported of a patient who survived rabies after the use of heavy sedation in addition to antiviral medication,[33] but other clinicians were unsuccessful using the same method.[34] Before a patient is treated with these new therapies, the patient and their family should be informed of the possibility of severe neurological sequelae even if the patient did recover.[3]

Post-exposure prophylaxis (PEP)

Animal and human rabies still occurs in many Asian countries, although neither animal nor human rabies has been reported in Japan since 1957. Travelers in the endemic regions who are bitten by a possibly rabid animal need to receive PEP as early as possible. The World Health Organisation (WHO) recommends the following post-exposure treatment.[3] The bite wound should be thoroughly washed with soap and water. Next, as much human rabies immunoglobulin (HRIG, 20 IU/kg) or equine rabies immunoglobulin (ERIG, 40 IU/kg) as possible should be injected around the wound, and the remainder should be given intramuscularly. In addition, a tissue-culture-inactivated rabies vaccine should be administered on days 0, 3, 7, 14, and 30, and also on day 90 if necessary. PEP should be given to patients who request treatment even months after the bite, since an incubation period of longer than 12 months has been reported in 6%–7% of rabies cases.

The risk of contracting rabies will be higher when the patient is bitten on bare skin as opposed to through clothing, because the rabies virus is highly concentrated in the saliva. Moreover, when the face or the fingers are bitten, the incidence of rabies tends to be higher and the incubation period tends to be shorter than when the lower limbs are bitten.

Inactivated rabies vaccines marketed throughout the world are effective against lyssaviruses belonging to Phylogroup I, but are not effective against Phylogroup II.[3]

In Japan, a tissue-culture-inactivated rabies vaccine for human use (PCEC–K) is produced by a private manufacturer, the Chemo-Sero-Therapeutic Research Institute (Kaketsuken). However, neither HRIG nor ERIG is produced or imported in Japan, and furthermore, the Japanese Government has no stock of RIG. As RIG is not available in Japan, following the WHO recommendation for rabies PEP is not feasible in practice.

The PCEC-K vaccine is prepared from an attenuated rabies strain, HEP–Flury, which is grown in primary cultures of chick embryo cells. It is then inactivated with betapropiolactone, followed by concentration and purification.[35] Its antigen titer has not been officially announced. Researchers in Thailand reported that PCEC–K is less potent than rabies vaccines produced in France and Germany.[36]

PEP in our vaccine clinic

During 2000–2005, the number of patients visiting our vaccine clinic to receive PEP after being bitten by a supposed rabid animal abroad was 71–84 per year except in 2003, when the severe acute respiratory syndrome (SARS) suddenly occurred (Fig. 2). Among these patients, about 30% and 20% were between the ages of 20–24 years and 25–29 years, respectively. Eighty percent of the patients were bitten by animals in Asian countries, and in particular Thailand (40%). In detail, 81% of subjects were bitten by dogs, 11% by monkeys, and 4% by cats. About 55% of the patients attacked by animals overseas visited a local medical institute and received a rabies vaccine. The remaining 45% returned to Japan without receiving proper treatment abroad, and visited our clinic after being warned by their family members or friends of the possibility of rabies and the need for PEP.

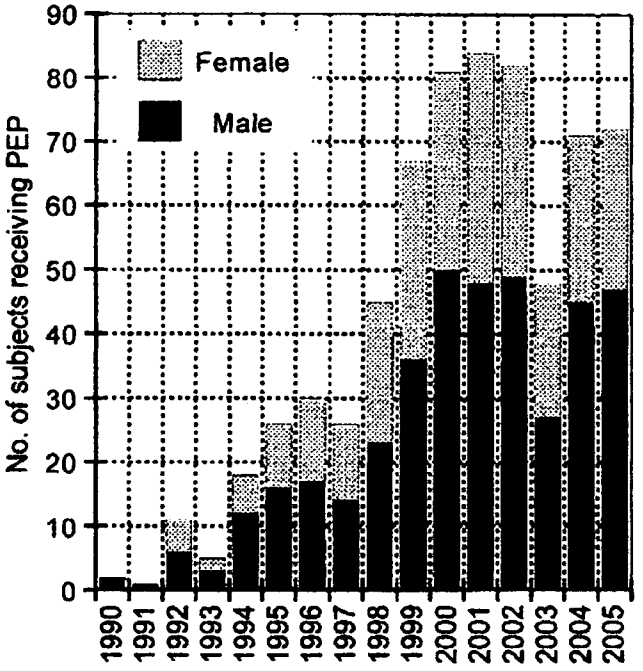

Fig. 2. The annual number of patients visiting our vaccine clinic to receive rabies post-exposure prophylaxis (PEP). The first overseas traveler bitten by a stray dog and requesting rabies PEP came to our vaccine clinic in 1990. The number of individuals receiving PEP annually in our clinic remained below 20 until 1994. However, it exceeded 20 in 1995, and continued to increase from 1997 to 2001. During this period, the annual number of Japanese people going abroad was increasing. However, we cannot explain the increase in the number of patients requesting rabies PEP simply by the rise in the number of Japanese international travelers. One speculation is that the need for rabies PEP has gradually been recognized among young Japanese adults attacked by suspected rabid animals abroad because nowadays they can easily obtain information through the Internet. On the other hand, not so many Japanese medical institutions have rabies vaccine in stock, which leads to a concentration of patients at the limited number of hospitals capable of providing rabies PEP. The decrease in the number of such patients in 2003 seems to have been caused by the outbreak of severe acute respiratory syndrome (SARS)

Imported rabies cases

In France, 19 cases of imported rabies have been reported since 1977. In England, 20 imported rabies cases were reported from 1946 to 2000. Since 2001, 2 cases have been reported in Germany, and one case each in France, England, and Taiwan.[37]

In Japan, three cases of imported rabies have been reported as of July 2007. The first case was a young adult who was bitten by a stray dog in Katmandu, Nepal, during a personal trip. About 1 month later, he complained of respiratory distress and died on the day of admission to hospital. He did not receive rabies PEP in either Nepal or Japan. Rabies was diagnosed based on the findings of a postmortem histological examination. The second and third cases were both men in their sixties.[1,2] During their long stay in the Philippines they were bitten by privately owned dogs, and they returned to Japan in November 2006 without having received rabies PEP. In both patients, the rabies virus was isolated from the saliva, and they were both diagnosed antemortem. By analyzing the gene, the rabies virus strains isolated were identified as the strain transmitted in the Philippines. In the third case, it was possible for medical staff to take the preventive measures recommended by the Center for Diseases Control and Prevention,[38] as the diagnosis was made shortly after the clinical symptoms appeared. This case was given similar treatment to the 15-year-old survival case,[31] but the treatment was unsuccessful.[1]

Pre-exposure immunization

Pre-exposure vaccination against rabies is a useful measure to prevent imported rabies. Pre-exposure immunization is recommended to people who are living in, or traveling to, high-risk regions. The WHO recommends a dose of tissue-culture rabies vaccine, with a potency of at least 2.5 IU per dose, to be given intramuscularly on days 0, 7, and 28.[3]

In Japan, pre-exposure immunization consists of two doses of PCEC–K given 30 days apart, and an additional dose given 6 months after the second dose.[35] Japanese travelers rarely plan their trip 6 months or more in advance, with the exception of some public employees. In many cases, the period available before leaving Japan is 2 months at the most. When they do not have enough time to complete the three doses, we recommend taking at least 2 doses. It is reasonably thought that patients who are bitten by a supposed rabid animal in an endemic area could efficiently produce antirabies antibody after receiving another two or three doses of the vaccine, and that they would then be protected against rabies without using RIG.

It is safer for people who are scheduled to be engaged in outdoor investigations or to handle animals to receive three doses of rabies vaccine, as recommended by the WHO, before leaving for rabies-endemic countries.

Conclusion

Half a century has passed since rabies was eradicated in Japan. However, countries free from rabies are exceptionally rare. Travel to Asian countries where many rabies victims still occur is easy, and only takes a few hours by airplane from Japan. Since Japanese travelers are rarely aware of rabies, they are at great risk of being bitten by a potentially rabid animal. Even if domestic human rabies cases no longer occur in Japan, imported rabies cases are always possible. Therefore, it is clearly important that no traveler ever carelessly puts out a hand to an animal in a rabies-endemic country. If a traveler is bitten by a suspected rabid animal in a rabies-endemic region, it is important that they receive rabies PEP in a local medical institution immediately. At the same time, pre-exposure vaccination against rabies should be recommended to international travelers in order to ensure the preventive effect of PEP. We should never forget that rabies is a preventable, but incurable, disease.

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感染症に及ぼす地球温暖化の影響

Effect of global worming on infectious diseases

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Key words：地球温暖化，熱帯感染症，節足動物媒介感染症

はじめに

近年，世界各地で異常気象が注目されている．国内では，2004年の年平均気温の上昇が観測史上第2位を記録，東京では真夏日が40日連続して多くの熱中症患者の発生が報告されたのはまだ記憶に新しい．また，この前年の2003年夏に欧州を襲った熱波では，パリの高齢者を中心に多数の死者が出た．気象庁によれば，1998-2004年の間に年平均気温の上昇が2℃以上であった地域は圧倒的に北半球に多く，熱帯地域ではむしろ平年並みであった地域が多かったとされている．

いずれにしても年平均気温の上昇が短期，中期，長期的変動によるものなのか，昨今国際社会が危惧している各種温室効果ガスの大気中への蓄積によって地球温暖化が加速度的に進行していることが異常気象の主因であるかは，この問題の門外漢である著者らには不明である．しかし，このような地球温暖化がたとえ10年単位でも持続すれば，現在の熱帯地域を中心に生息している病原生物およびその伝播に関与する媒介生物などの生息域が温帯地域にまで拡大されることが懸念される[1]．

‘気候変動に関する政府間パネル(Intergovernmental Panel on Climate Change: IPCC)’は，2100年頃までに地球の年平均気温が1.4-5.8℃上昇すると予測している．これは等温線が極方向へ210-640 kmほど移動することを意味しており，最大で那覇市がほぼ宮崎市の位置に，また宮崎市が福島市の位置にまで移動することと同じであると見積もられている．更に年平均気温だけでなく，冬季における最低気温も上昇すると考えられている．

その結果，このような地球規模の温暖化によって感染症の蔓延が懸念されており，IPCCの第2分科会では気候の変化が感染症に及ぼす影響について報告書を提出した[2]．そこで，本稿ではこの報告書を基に，地球温暖化が感染症に及ぼす影響について解説する．

1. 感染症流行に及ぼす諸因子

気温や湿度，降雨量，海水面の上昇といった気候の変動は感染症の伝播に影響を与えると誰もが考えているが，これらの要因が媒介動物由来感染症(vector-borne infectious diseases)にどのように関与しているかを解明することは容易ではない．媒介動物感染症の発生件数や地理的分布に与える要因には気候の変動のみならず社会学的要因や人口動態学的要因も複雑に絡み合っており，媒介動物の個体数が増加してその生息域を拡大したからといって感染症による死亡率が単純に上昇するわけではない．

感染症の伝播には病原体とそれを保有する宿

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主(reservoir host)，更に病原体を運搬する媒介動物が同じ時空間に十分量存在しなければならない．これが更にヒトへと感染するためには，人口密度や居住様式とその環境，ヒトの行動様式，上水道の普及率，廃棄物処理システム，土地の利用形態，灌漑設備の有無，行政による媒介動物コントロールプログラムが有効に機能しているか否かといった環境衛生面の様々な因子もまた深くかかわっている．

更に，人口の増加や急激な都市化，戦争などによる開発途上国における公衆衛生基盤の崩壊，ヒトとモノの国境を越えた移動，ヒトと動物の関係の変化などは近年における感染症流行のとりわけ大きな要因となっており，気候変動因子はこれらの因子に比べると直接的な影響は限られている．しかし，気候変動における影響は地球規模に及び，開発途上国のみならず先進国にも深刻な影響を与え得る．

2. 感染症流行に及ぼす気候要因

地球温暖化による熱帯感染症の流行は，その多くが特定の動物によって媒介される媒介動物由来感染症としての側面をもっている．これらの媒介動物が温暖化の影響で越冬が可能となり，その生息域を拡大し，それにつれて疾病流行域も拡大することが予測される．例えば，気温の上昇は媒介動物の個体数の増加とともに，空間的季節的分布域の拡大を招き，これが更に媒介動物とヒトとの接触の機会を増加させる．病原体にとっては，媒介動物体内での生存期間が延びることによる疾病流行期間の延長と流行域の拡大が懸念される．

降雨量の増大は媒介動物の生息環境を質的にも量的にも拡大させるであろう．例えば，住血吸虫症の流行地において洪水が発生すると，その下流域では感染貝の新たな繁殖地が出現する可能性がある．高温多湿は媒介動物の繁殖に有利に作用し，多湿はハマダラカ体内におけるマラリア原虫の発育を助長するという研究がある．

ネズミの尿中に病原体が排泄されるレプトスピラ症では，洪水によって病原体を含む排泄物の拡散が考えられる．また，上水道の完備していない開発途上国では，降雨量が減少すると飲料水を確保するために瓶などに水を貯蔵しておく機会が増えるであろう．これらの貯水容器内ではデング熱を媒介するネッタイシマカなどの蚊類が繁殖する．逆に，干ばつが起これば感染症を媒介する貝は減少すると予想される[2,3]．

3. 温暖化により流行拡大が懸念される感染症

このように，気候要因のうち平均気温の上昇と降雨量の増加，最低気温の上昇が感染症流行に最も影響を与える．**表1**に地球温暖化によって流行の拡大が懸念される感染症とその媒介動物をあげた．以下，代表的な疾患について解説する．

a. デング熱

デング熱はフラビウイルス属のデングウイルスによって起きる感染症で，4種の血清型が知られている．症状からデング熱とデング出血熱を区別する．感染はヤブカ(*Aedes*)属の蚊によって媒介される．なかでもネッタイシマカ(*A. aegypti*)とヒトスジシマカ(*A. albopictus*)はウイルス媒介能が高く重要な媒介蚊である．

ヒトスジシマカは国内にも広く分布しているが，ネッタイシマカの生息は確認されていない．津田ら(2001年)の長崎市内における実験では，3月に戸外においたヒトスジシマカの幼虫の半数近くは長崎の低温期を生き抜き外気温が10℃以上になる4月になると成虫にまで発育したが，これ以外の時期ではすべて死亡したという[4]．また，ネッタイシマカでは発育零点(理論上幼虫の発育が停止する温度)が更に高く，現時点では国内でネッタイシマカが繁殖する可能性はないと述べている．しかし，年平均気温が5℃上昇し，最低気温が10℃を下回らないほど温暖化が進めば，ネッタイシマカが定着することは十分考えられる．

現在，デング熱患者の発生地域は熱帯アジア，南太平洋，中南米，アフリカ諸国の100カ国以上にも上り，エルニーニョ現象が起きると気温が上昇し，蚊が増加して発生率が高くなる．

デング出血熱は1950年代にデング熱が流行

表1　地球温暖化によって蔓延するおそれのある節足動物媒介感染症

	感染症名	病原体	媒介動物	重要種	ヒトへの感染経路	ヒト以外の宿主
ウイルス性疾患	黄　熱	黄熱ウイルス	ヤブカ属	ネッタイシマカ	蚊→ヒト(吸血)	サ　ル
	デング熱	デングウイルス	ヤブカ属	ネッタイシマカ，ヒトスジシマカ	蚊→ヒト(吸血)	ヒトのみ
	リフトバレー熱	リフトバレー熱ウイルス	イエカ，ヤブカなど多くの種類の蚊		蚊→家畜→ヒト(解体時の飛沫感染)	ヒツジ(本来の宿主)，ウシ
リケッチア性疾患	発疹チフス	発疹チフスリケッチア	ヒトシラミ	コロモジラミ	ヒトシラミ→ヒト(刺咬) シラミ糞便→ヒト(創傷感染)	ヒトのみ
寄生虫性疾患	マラリア	*Plasmodium* 属原虫	ハマダラカ属蚊	シナハマダラカ	蚊→ヒト(吸血)	ヒトのみ
	リーシュマニア症	*Leishmania* 属原虫	サシチョウバエ		サシチョウバエ→ヒト(吸血)	イヌ，ネコ，ネズミなど
	アフリカトリパノソーマ症	*Trypanosoma gambiense*, *T. rhodesiense*	ツェツェバエ		ツェツェバエ→ヒト(吸血)	ブタ，(*T. g*)，ガゼルなどの野生動物(*T. r*)
	アメリカトリパノソーマ症	*Trypanosoma cruzi*	サシガメ		サシガメ糞便→ヒト(創傷感染)	イヌ，ネコ，アルマジロなど
	糸状虫症	バンクロフト糸状虫	多くの種類の蚊	アカイエカ	蚊→ヒト(吸血)	ヒトのみ
		マレー糸状虫	多くの種類の蚊	トウゴウヤブカ	蚊→ヒト(吸血)	サル，イヌ，ネコ
		回旋糸状虫(オンコセルカ)	ブ　ユ	*Simulium* 属	ブユ→ヒト(吸血)	ヒトのみ
		ロア糸状虫	ア　ブ	*Chrysops* 属	アブ→ヒト(吸血)	ヒトのみ
		常在糸状虫	ヌカカ		ヌカカ→ヒト(吸血)	ヒトのみ