

In the 1960s, it appeared that human African trypanosomiasis (HAT) could be effectively controlled, but by the beginning of the twenty-first century several decades of neglect had led to alarming numbers of reported new cases, with an estimated 300 000 people infected. The World Health Organization (WHO) responded with a series of initiatives aimed at bringing HAT under control again. Since 2001, the pharmaceutical companies that produce drugs for HAT have committed themselves to providing them free of charge to WHO for distribution for the treatment of patients. In addition, funds have been provided to WHO to support national sleeping sickness control programmes to boost control and surveillance of the disease. That, coupled with bilateral cooperation and the work of nongovernmental organizations, helped reverse the upward trend in HAT prevalence. By 2012, the number of reported cases was fewer than 8000. This success in bringing HAT under control led to its inclusion in the WHO Roadmap for eradication, elimination and control of neglected tropical diseases, with a target set to eliminate the disease as a public health problem by 2020. A further target has been set, by countries in which HAT is endemic, to eliminate gambiense HAT by reducing the incidence of infection to zero in a defined geographical area.

This report provides information about new diagnostic approaches, new therapeutic regimens and better understanding of the distribution of the disease with high-quality mapping. The roles of human and animal reservoirs and the tsetse fly vectors that transmit the parasites are emphasized. The new information has formed the basis for an integrated strategy with which it is hoped that elimination of gambiense HAT will be achieved. The report also contains recommendations on the approaches that will lead to elimination of the disease.

# Control and surveillance of human African trypanosomiasis

Report of a WHO Expert Committee



The World Health Organization was established in 1948 as a specialized agency of the United Nations serving as the directing and coordinating authority for international health matters and public health. One of WHO's constitutional functions is to provide objective and reliable information and advice in the field of human health, a responsibility that it fulfils in part through its extensive programme of publications.

The Organization seeks through its publications to support national health strategies and address the most pressing public health concerns of populations around the world. To respond to the needs of Member States at all levels of development, WHO publishes practical manuals, handbooks and training material for specific categories of health workers; internationally applicable guidelines and standards; reviews and analyses of health policies, programmes and research; and state-of-the-art consensus reports that offer technical advice and recommendations for decision-makers. These books are closely tied to the Organization's priority activities, encompassing disease prevention and control, the development of equitable health systems based on primary health care, and health promotion for individuals and communities. Progress towards better health for all also demands the global dissemination and exchange of information that draws on the knowledge and experience of all WHO's Member countries and the collaboration of world leaders in public health and the biomedical sciences.

To ensure the widest possible availability of authoritative information and guidance on health matters, WHO secures the broad international distribution of its publications and encourages their translation and adaptation. By helping to promote and protect health and prevent and control disease throughout the world, WHO's books contribute to achieving the Organization's principal objective – the attainment by all people of the highest possible level of health.

The *WHO Technical Report Series* makes available the findings of various international groups of experts that provide WHO with the latest scientific and technical advice on a broad range of medical and public health subjects. Members of such expert groups serve without remuneration in their personal capacities rather than as representatives of governments or other bodies; their views do not necessarily reflect the decisions or the stated policy of WHO.

For further information, please contact WHO Press, World Health Organization; 1211 Geneva 27, Switzerland; [www.who.int/bookorders](http://www.who.int/bookorders); tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: [bookorders@who.int](mailto:bookorders@who.int).

## SELECTED WHO PUBLICATIONS OF RELATED INTEREST

---

**Report of a WHO meeting on elimination of African trypanosomiasis  
(*Trypanosoma brucei gambiense*),**

Geneva, 3–5 December 2012  
WHO/HTM/NTD/IDM/2013

**Report of a WHO informal consultation on sustainable control of human  
African Trypanosomiasis**

Geneva, 1–3 May 2007  
WHO/CDS/NTD/IDM/2007.6

**Recommendations of the informal consultation on issues for clinical product  
development for human African trypanosomiasis**

Geneva, 9–10 September 2004

**Control and Surveillance of African Trypanosomiasis,**

Geneva, World Health Organization, 1995  
WHO Technical Report Series, No. 881

**Epidemiology and control of African trypanosomiasis,**

Geneva, World Health Organization, 1986  
WHO Technical Report Series, No. 739

**The African trypanosomiasis,**

Geneva, World Health Organization, 1979  
WHO Technical Report Series, No. 635

**African Trypanosomiasis,**

Geneva, World Health Organization, 1969  
WHO Technical Report Series, No. 434

**Comparative Studies of American and African trypanosomiasis,**

Geneva, World Health Organization, 1969  
WHO Technical Report Series, No. 411

**Expert Committee on Trypanosomiasis,**

Geneva, World Health Organization, 1962  
WHO Technical Report Series, No. 247

# Control and surveillance of human African trypanosomiasis

---

Report of a WHO Expert Committee

*This report contains the collective views of an international group of experts and  
does not necessarily represent the decisions or the stated policy of the World Health Organization*



**World Health  
Organization**

WHO Library Cataloguing-in-Publication Data:

Control and surveillance of human African trypanosomiasis: report of a WHO expert committee.

(WHO technical report series ; no. 984)

1.Trypanosomiasis, African – prevention and control. 2.Trypanosomiasis, African – epidemiology. 3.Trypanosoma - classification. I.World Health Organization. II.WHO Expert Committee on the Control and Surveillance of Human African Trypanosomiasis (2013: Geneva, Switzerland). III. Series.

ISBN 978 92 4 120984 7

(NLM classification: WC 705)

ISBN 978 92 4 069172 8 (PDF)

ISSN 0512-3054 4

**©World Health Organization 2013**

All rights reserved. Publications of the World Health Organization are available on the WHO web site ([www.who.int](http://www.who.int)) or can be purchased from WHO Press, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland (tel.: +41 22 791 3264; fax: +41 22 791 4857; e-mail: [bookorders@who.int](mailto:bookorders@who.int)).

Requests for permission to reproduce or translate WHO publications –whether for sale or for non-commercial distribution– should be addressed to WHO Press through the WHO web site ([www.who.int/about/licensing/copyright\\_form/en/index.html](http://www.who.int/about/licensing/copyright_form/en/index.html)).

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this publication. However, the published material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

This publication contains the collective views of an international group of experts and does not necessarily represent the decisions or the policies of the World Health Organization.

**Printed in Italy**

# Contents

<b>Abbreviations and acronyms</b>	viii
<b>WHO Expert Committee on control and surveillance of human African trypanosomiasis</b>	ix
<b>1. Introduction</b>	1
<b>2. Epidemiology of human African trypanosomiasis</b>	3
2.1 Two diseases, two parasites, two epidemiological patterns	3
2.2 Transmission cycle	4
2.2.1 Gambiense human African trypanosomiasis	4
2.2.2 Rhodesiense human African trypanosomiasis	5
2.3 Reservoirs of infection	6
2.3.1 Gambiense human African trypanosomiasis	6
2.3.2 Rhodesiense human African trypanosomiasis	7
2.4 Risk factors for infection	10
2.4.1 Gambiense human African trypanosomiasis	10
2.4.2 Rhodesiense human African trypanosomiasis	12
2.5 Trends in numbers of cases reported	13
2.5.1 Gambiense human African trypanosomiasis	13
2.5.2 Rhodesiense human African trypanosomiasis	17
2.6 Geographical distribution and population at risk	19
2.7 Global environmental change	27
2.8 References	27
<b>3. The parasite</b>	42
3.1 Taxonomy of human infectious African trypanosomes	42
3.2 Morphology and cell structure	44
3.3 Life-cycle	46
3.4 The <i>Trypanosoma brucei</i> genome	49
3.5 Immune evasion	51
3.6 Biochemistry and modes of drug action	52
3.7 Drug resistance	53
3.8 References	55
<b>4. The vector</b>	62
4.1 Classification	63
4.1.1 Subgenus <i>Nemorhina</i>	65
4.1.2 Subgenus <i>Glossina</i> s. str.	65
4.1.3 Subgenus <i>Austenina</i>	66
4.2 Reproductive system	66
4.3 Reproduction	67
4.4 Lifespan and population dynamics	69
4.5 Diet	70
4.6 Geographical distribution of the main vector species	71
4.6.1 Vector species of the <i>Nemorhina</i> subgenus	72
4.6.2 Vector species of the <i>Glossina</i> s. str. subgenus	73
4.6.3 Vector species of the <i>Austenina</i> subgenus	74

4.7	Tsetse flies in their natural environment	74
4.7.1	Main habitats	74
4.7.2	Movements	76
4.7.3	Looking for hosts	76
4.7.4	Feeding preferences	77
4.7.5	Activity cycles	78
4.7.6	Dispersal	78
4.7.7	Resting places	79
4.8	Population genetics and geometric morphometrics	79
4.9	Genomics of tsetse flies	80
4.10	Tsetse flies as cyclical vectors	81
4.11	Vector control strategies	82
4.11.1	Control	82
4.11.2	Eradication	82
4.11.3	Preliminary surveys	83
4.12	Tsetse fly control methods	83
4.12.1	Bush clearing	83
4.12.2	Elimination of wild animal hosts	84
4.12.3	Biological control of tsetse flies	84
4.12.4	Autonomous control of tsetse flies	84
4.12.5	Indigenous tsetse fly control practices	84
4.12.6	Ground and aerial insecticide spraying	84
4.12.7	Protecting zero grazing units by insecticide-impregnated netting	85
4.12.8	Bait methods	87
4.12.9	Olfactory baits (attractants) for tsetse flies	89
4.12.10	Live baits	89
4.12.11	Sterile insect technique	91
4.13	New developments and outlook	91
4.14	References	92

## 5. The disease 103

5.1	Gambiense human African trypanosomiasis: clinical signs and symptoms	103
5.1.1	Lymphadenopathy	103
5.1.2	Fever	104
5.1.3	Headache	104
5.1.4	Pruritus	104
5.1.5	Musculoskeletal pain, hepatomegaly and splenomegaly	104
5.1.6	Cardiac involvement	104
5.1.7	Gastrointestinal symptoms	105
5.1.8	Oedema	105
5.1.9	Sleep disorder	105
5.1.10	Neuropsychiatric symptoms and signs	105
5.1.11	Endocrine disorders	106
5.2	Rhodesiense human African trypanosomiasis: clinical signs and symptoms	108
5.3	Specific groups	108
5.3.1	Children	108
5.3.2	HIV-coinfected patients	109
5.3.3	Human African trypanosomiasis in nonendemic countries	109
5.4	Sequelae	110
5.5	References	110

<b>6. Diagnosis</b>	118
6.1 Diagnosis of gambiense human African trypanosomiasis	119
6.1.1 Antibody detection	119
6.1.2 Parasite detection	123
6.1.3 Molecular detection	126
6.2 Diagnosis of rhodesiense human African trypanosomiasis	128
6.2.1 Antibody detection	128
6.2.2 Parasite detection	128
6.2.3 Molecular detection	129
6.3 Disease stage determination	130
6.3.1 White blood cell count	131
6.3.2 Parasite detection in cerebrospinal fluid	132
6.3.3 Other staging markers	132
6.3.4 Molecular tests	132
6.4 Treatment outcome assessment	132
6.5 Quality control of diagnostic testing	135
6.6 New developments and outlook	135
6.7 References	137
<b>7. Treatment</b>	150
7.1 Pharmacology of drugs for treatment of first-stage human African trypanosomiasis	153
7.1.1 Pentamidine	153
7.1.2 Suramin	155
7.2 Pharmacology of drugs for treatment of second-stage human African trypanosomiasis	157
7.2.1 Melarsoprol	157
7.2.2 Eflornithine	160
7.2.3 Nifurtimox	161
7.3 First-line treatment	162
7.3.1 First-stage gambiense human African trypanosomiasis: pentamidine	162
7.3.2 First-stage rhodesiense human African trypanosomiasis: suramin	163
7.3.3 Second-stage gambiense human African trypanosomiasis: nifurtimox– eflornithine combination therapy	164
7.3.4 Second-stage rhodesiense human African trypanosomiasis: melarsoprol	165
7.4 Alternative treatments for second-stage gambiense human African trypanosomiasis	167
7.4.1 Eflornithine monotherapy	167
7.4.2 Melarsoprol	167
7.5 Treatment in pregnancy	168
7.6 New developments and outlook	168
7.6.1 Preclinical and clinical developments	168
7.6.2 Research on other compounds	171
7.7 References	172
<b>8. Control and elimination</b>	189
8.1 Detection of cases of gambiense human African trypanosomiasis	189
8.1.1 Active case detection	190
8.1.2 Passive case detection	191
8.1.3 Management of parasitologically unconfirmed seropositive cases	192
8.2 Detection of cases of rhodesiense human African trypanosomiasis	193
8.2.1 Active case detection	194



8.2.2	Passive case detection	194
8.3	Control of animal reservoirs	195
8.3.1	Control in the domestic livestock reservoir	195
8.3.2	Control in the wildlife reservoir	196
8.4	Vector control	196
8.4.1	Methods	196
8.4.2	Traps and screens	196
8.4.3	Insecticide-treated cattle for control of rhodesiense human African trypanosomiasis	197
8.4.4	Implementation of vector control	198
8.5	Elimination of gambiense human African trypanosomiasis	199
8.5.1	Rationale	199
8.5.2	Concept of elimination, indicators and benchmarks	200
8.5.3	Strategies for elimination	201
8.5.4	Challenges	204
8.6	Elimination of rhodesiense human African trypanosomiasis	204
8.7	References	205
<b>9.</b>	<b>Recommendations</b>	215
	<b>Acknowledgements</b>	219
	<b>Annexes</b>	220
	<b>Annex 1</b>	
	Wild animal species documented as serving as hosts for <i>Trypanosoma brucei rhodesiense</i>	220
	<b>Annex 2</b>	
	Distribution of human African trypanosomiasis in West Africa	222
	<b>Annex 3</b>	
	Distribution of human African trypanosomiasis in Central Africa	223
	<b>Annex 4</b>	
	Distribution of human African trypanosomiasis in East and south-eastern	...

预览已结束，完整报告链接和

<https://www.yunbaogao.cn/report/index/report>