Ghana, but the proportional mortality was not higher than in children.

Third, Dhingra and colleagues have made no attempt to assess the validity of verbal autopsy procedures in India. The subset of deaths (14%) in this study that had occurred in a health facility could have been used in a validation exercise. Ascertaining proportional mortality attributable to malaria by use of verbal autopsy in areas of low malaria transmission has substantial limitations and the estimates of malaria mortality generated by this method should be interpreted with caution.

The letter represents the views of the authors but not the views of the US Centers for Disease Control and Prevention. We declare that we have no conflicts of interest.

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Neeraj Dhingra and colleagues[1] report higher estimates of annual malaria deaths in India than previously suggested. South Asia abounds in life-threatening undifferentiated febrile illnesses like malaria. Typhoid, typhus (rickettsial illness), leptospirosis, and dengue are some of the common diseases that mimic malaria. The transmission rate of typhoid fever, for example, is 1600 per 100 000 population in some parts, and conservative annual estimates of typhoid deaths worldwide are about 200 000.[2] Blood cultures, when available, are only positive in about 50% of cases, and typhoid, like malaria, remains a largely undiagnosed disease in the community.

Additionally, in a large fever study[3] in south Asia, typhus and leptospirosis were very important causes of undifferentiated fever, yet none of the treating physicians was sufficiently informed about these diseases to put them down as differential diagnoses. Unlike for malaria, however, studies on these undifferentiated febrile illnesses, including typhoid fever, are poorly funded. Indeed, the burden of disease for these common illnesses remains unknown owing to a severe lack of proper fever diagnostics.

Against this background, more concrete proof of malaria with better methods might be required to establish Dhingra and colleagues' claims about increased malaria mortality in India.

I declare that I have no conflicts of interest.

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The methods used by Neeraj Dhingra and colleagues[1] have some potential sources of inaccuracy and bias, which could alter the number of malaria-attributed deaths. Although Dhingra and colleagues were quite fastidious in their methods, concerns about the accuracy of diagnoses by physicians

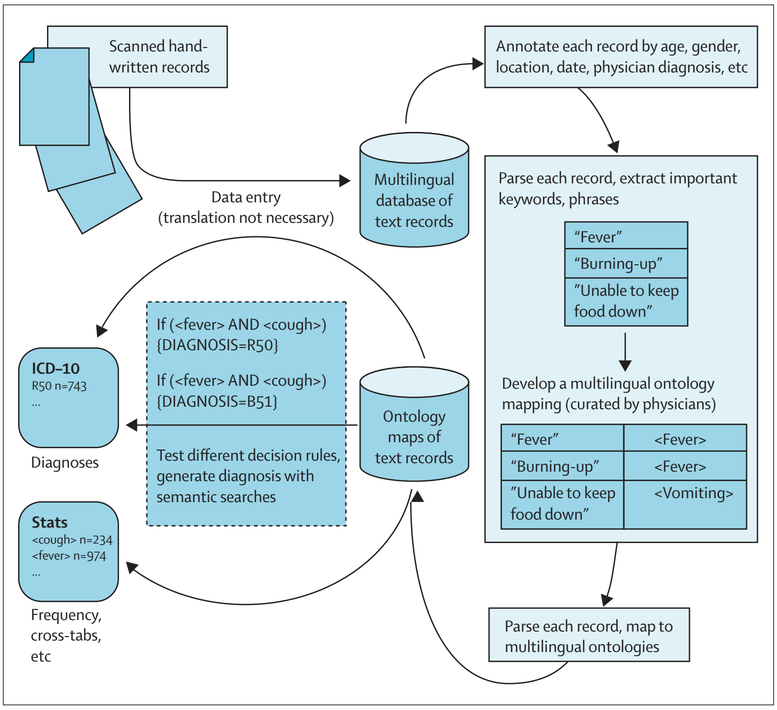

Figure: **A computational approach to diagnosis and calculation of the number of deaths related to malaria in India**
ICD=International Classification of Diseases.

and the quality of the original narratives persist.

No descriptive statistics concerning keywords, length, or the frequency of other diagnoses were presented. Faulty decision algorithms for malaria or other diseases might have artificially increased the number of malaria deaths. If "cough" appears in 99% of Gujarati narratives, then it might lack diagnostic use in Gujarati narratives. Descriptive statistics could help address such diagnostic dilemmas.

A computerised database that uses text mining and biomedical ontologies[2] could address these concerns (figure). Biomedical ontologies are structured representations of knowledge that can be used for decision support and computerised data storage.[2] Many examples of biomedical ontologies exist[3,4] and future versions of the International Classification of Diseases will be ontology-based.[5] In Dhingra and colleagues' study, untranslated medical narratives could be analysed by use of a biomedical ontology. Descriptive statistics and cross-tabulations could be calculated to provide insight into language and cultural bias, whether or not longer documents are more likely to be assigned a diagnosis of malaria, etc. The diagnostic outcomes of different decision algorithms could be explored quickly, and the number of malaria-attributed (or otherwise) deaths recalculated. This process is less inconsistent, less work-intensive, and less error-prone than a human approach. It could also help refine the malaria estimates provided by Dhingra and colleagues.

I declare that I have no conflicts of interest.

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Authors' reply

Malaria can be cured easily if treated promptly. The Indian National Vector-Borne Disease Control Programme diagnoses about 1 million cases of *Plasmodium falciparum* annually. It successfully treats nearly all cases it diagnoses, reporting among them only about 0·1% mortality.[1] But, since infection with *P falciparum* can progress rapidly from mild symptoms to life-threatening disease, in some of the parts of India with limited health-care facilities, many cases are never diagnosed and malaria remains a major cause of death. Most of the deaths attributed to malaria in our study were in rural villages among people whose acute fever was never seen by any health-care worker, so there was, of necessity, no reliable diagnosis of the pathogen. Nevertheless, national malaria mortality estimates for India should attribute to malaria some proportion of the many rural deaths from medically unattended acute fevers, while acknowledging the inevitable uncertainties that this involves.

Our study is a nationally representative sample, organised wby the Registrar-General, of all deaths in India.[2,3] It therefore included large numbers of unattended rural deaths from an undiagnosed illness that had caused fever. Trained non-medical graduate fieldworkers interviewed family members. The fieldworker's written narrative of the course of the fatal episode was scanned electronically then sent to two different places to be coded independently by two of 130 trained physicians. Of the rural unattended fever deaths before age 70 years, 11% were eventually attributed to malaria (table), with higher proportions in the state of Orissa, where *P falciparum* transmission is most intense.[1] Within states, the proportion of deaths the coders attributed to malaria also correlated at district level with *P falciparum* transmission.

Most of the deaths eventually attributed to malaria were independently attributed to malaria by both of the two physicians at initial coding. Despite this concordance, the classification of an *individual* fever death as malarial or non-malarial is

	Number of deaths	Proportion attributed to various types of infection					
		Malaria	Pneumonia	Tuberculosis	Diarrhoea	Other infection	Fever of unknown origin
Orissa	1388	601 (43%)	197 (14%)	204 (15%)	185 (13%)	170 (12%)	31 (2%)
Other high-malaria states*	4336	770 (16%)	1137 (28%)	655 (15%)	698 (16%)	776 (18%)	300 (8%)
Rest of India	11 114	773 (7%)	3247 (29%)	1994 (18%)	1801 (17%)	2400 (22%)	939 (8%)
All India	16 838	2104 (11%)	4581 (28%)	2853 (17%)	2684 (16%)	3346 (20%)	1270 (8%)

Proportions are sample-weighted to the Sample Registration System sampling fractions in the rural and urban parts of each state. Unweighted proportions yielded nearly identical reults. *Chhattisgarh, Jharkhand, Madhya Pradesh (which was not included with the high-malaria states in the study report) and the northeastern states.

***Table:* Number of rural deaths with fever at ages 0–69 years that did not occur in a health-care facility, and proportions attributed by coders to various types of infection, by area**