to have died in the conflict or are missing (*1*). Health services, especially those supporting women and children, were severely disrupted, with over 35% of facilities destroyed or heavily damaged. To assess the impact of the conflict on the health status of women and children, we compared the following traditional indicators with information from the previous decade.

Data on women of reproductive age (15–49 years) and children (0–15 years) in Bosnia and Herzegovina were collected from two main sources: routine official reporting systems and a nationally representative survey of households, women and children carried out in mid-2000 (*2*). Numerator data from the official reporting systems were extracted for the year 1991 and the most recent year for which complete information was available. Denominator data were available from the 1991 census; best available state estimates were used for the most recent year.

The national survey covered 10 772 households, with a response rate of >98%; it was carried out using standardized United Nations Children's Fund (UNICEF) methodology, described elsewhere (*3*). The results suggest that the health of women and children in Bosnia and Herzegovina has not worsened in the last decade — in fact several indicators, including infant mortality rate and maternal mortality ratio, show improvement. These findings are extremely surprising, given four years of war and its consequences. Although the second half of the decade has seen rebuilding of essential services, the economic situation and health and other services remain far below pre-war standards (*1*).

Underlying factors suggest that the data quality may be poor. Official data collection systems are under considerable pressure and there is little systematic effort to assess or improve data quality. The unclarity is compounded by significant concerns about the denominator population data used to calculate rates, with uncertainty surrounding true figures for deaths and refugee and migrant populations. Despite being widely used, we also question the appropriateness of relying solely on traditional indicators such as infant and maternal mortality rates to assess the impact of the war — selective primary care can improve these indicators even when the general health status of the population deteriorates (*4*). The limitations of relying on such indicators, tested under "developing country paradigms", in responding to complex emergencies in more-developed countries has already been highlighted (*5*).

If our results indeed reflect a true stability in the health of this population, possible explanations include a good pre-war health status, resilience of the socialist primary health care, education and other basic systems that continued to function, and significant levels of external aid for postwar reconstruction (US$ 5.1 billion during the period 1995–99) (*1*).

These results are important because they suggest the possibility that good primary health care systems and adequate, targeted external assistance can protect the health of vulnerable populations such as women and children against the adverse effects of war. However, credence cannot be given to these claims as it may take many years for the impact of a conflict to be visible in traditional indicators, or it may be masked by an overall deterioration in the data collection systems. More research is needed to produce indicators that can adequately evaluate population health status, the resilience of local communities, and the protective effects of humanitarian assistance in conflict situations. This is especially relevant as these indicators routinely form the basis for international assistance. ■

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1. Independent Bureau for Humanitarian Issues. *Human development report: Bosnia and Herzegovina 1998*. Sarajevo: United Nations Development Programme; 1999.
2. United Nations Children's Fund Bosnia and Herzegovina. *Bosnia and Herzegovina multiple indicator cluster survey 2000*. Sarajevo: United Nations Children's Fund; 2001 (in press).
3. Division of Evaluation, Policy and Planning. *End-decade multiple indicator survey manual*. New York: United Nations Children's Fund; 2000.
4. Ugalde A, Selva-Sutter E, Castillo C, Paz C, Canas S. Conflict and health. The health costs of war: can they be measured? Lessons from El Salvador. *BMJ* 2000;321:169-72.
5. Spiegel PB, Salama P. Emergencies in developed countries: are aid organisations ready to adapt? *The Lancet* 2001;357:714.

The role of RT-PCR assay of oral fluid for diagnosis and surveillance of measles, mumps and rubella

Editor — The potential of oral fluid to replace serum for specific antibody detection for use in evaluating population immunity levels for important vaccine-preventable virus infections was recently discussed in the *Bulletin* (*1*). The important role of genotyping virus strains in surveillance of vaccine-preventable diseases to identify "escape mutants" and to investigate epidemiologically linked cases is well established. We report here an investigation of the rate of the virus shedding in oral fluid in patients with serological evidence of recent measles, mumps and rubella (MMR). While other clinical specimens such as blood, nasopharyngeal aspirate (NPA), throat swab and urine are recommended for testing for this purpose, oral fluid offers considerable compliance advantages to the patient and is easy and economical to collect.

In all, 1047 oral fluid samples were tested by reverse transcription polymerase chain reaction (RT-PCR) assay for MMR: 966 samples were collected as part of the salivary surveillance scheme in the United Kingdom (*2*) and had been previously tested for antibody (*3*), and 81 samples were obtained specifically for molecular studies from confirmed cases. All samples were collected using the Oracol device (Malvern Medical Developments, Worcester, UK) (*4*).

The results (Table 1) support MMR virus genome detection by RT-PCR in oral fluid samples collected during the first 14 days after onset of symptoms.

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Table 1. **Measles, mumps and rubella RT-PCR results on 1047 oral fluid samples from confirmed and clinically diagnosed cases by time from onset of clinical symptoms**

Virus	Collection purpose[a]	RT-PCR result (%) with days after onset				Total RT-PCR positive (%)
		0–7 days	8–14 days	>14 days	Not known	
Measles	surveillance	28/52 (54)	27/67 (40)	36/174 (21)	19/100 (19)	110/393 (28)
	RT-PCR	52/54 (96)	1/1 (100)	–	–	53/55 (96)
Mumps	surveillance	46/67 (69)	11/55 (20)	3/183 (1.6)	4/49 (8)	64/354 (18)
Rubella	surveillance	10/24 (42)	1/24 (4)	3/108 (2.8)	2/63 (3.2)	16/219 (7)
	RT-PCR	12/16 (75)	3/10 (30)	–	–	15/26 (58)
Total						**1047**

[a] Confirmed cases were collected for routine surveillance for antibody testing, and clinically diagnosed cases specifically for RT-PCR.

In contrast, MMR-specific IgM (*3*) may not be detected for several days after the onset of symptoms. The most important factor influencing the successful detection of viral genome by RT-PCR was the timing of sample collection, and detection rate decreased with time after onset of symptoms. A higher rate of RT-PCR positivity was also found in those samples which had not previously been used for detection of specific antibody, suggesting that oral fluids contain low levels of virus and that subjecting samples to cycles of freeze–thawing may damage genome copies. A further observation was that the proportion of oral fluid samples in which measles virus genome was detected was significantly higher than that for mumps and rubella ($P<0.001$). This suggests a longer lasting viraemia for measles, or that the immune system may take longer to clear measles than mumps or rubella viruses.

Oral fluid samples from isolated cases that are to be used for molecular studies should ideally be collected within 7 days of onset of illness and stored at –70 °C until required for testing. During large outbreaks or epidemics where large numbers of samples may be collected this is not so critical, and samples obtained and used for other purposes (e.g. antibody detection) may also be used for molecular studies. However, the likelihood of detection of virus genome is much reduced.

We have shown that oral fluid samples are a safe and practical alternative to blood, NPA, throat swabs and urine for molecular studies involving MMR. Sequencing of the PCR amplicon also enables the characterization of viral pathogens without cell culture, which is less sensitive and can be difficult and time-consuming. These results, together with those on antibody detection, reinforce the value of oral fluid samples for surveillance of MMR and highlight the need for more detailed studies to exploit fully the use of this method in surveillance programmes. ■

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1. Nokes DJ, Endquselassie F, Nigaru W, Vyse AJ, Cohen BJ, Brown DWG, et al. Has oral fluid the potential to replace serum for the evaluation of population immunity levels? A study of measles, rubella, and hepatitis B in rural Ethiopia. *Bulletin of the World Health Organization* 2001;79:588-95.
2. Gay N, Ramsay M, Cohen B, Hesketh L, Morgan-Capner P, Brown D, et al. The epidemiology of measles in England and Wales since the 1994 vaccination campaign. *Communicable Disease Report. CDR Review* 1997;7:R17-21.
3. Perry KR, Brown DW, Parry JV, Panday S, Pipkin C, Richards A. Detection of measles, mumps and rubella antibodies in saliva using antibody capture radioimmunoassay. *Journal of Medical Virology* 1993;40:235-40.
4. Brown DWG, Ramsay ME, Richards AF, Miller E. Salivary diagnosis of measles: a study of notified cases in the United Kingdom, 1991-3. *BMJ* 1994;308:1015-7.

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Authors should give their current appointments and full addresses, with a telephone or fax number or email address for the corresponding author. We ask authors to declare any conflict of interest.

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