Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

patients. A greater V_T at high VF can induce entrapment and auto-PEEP by limiting expiratory time; this phenomenon can be compensated by adjusting the splitter flow limiter. Use of splitters requires meticulous assembly but can be potentially useful in pandemic scenarios.

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Declarations of interest

The authors declare that they have no conflicts of interest.

Appendix A. Supplementary data

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Personal protective equipment provision amongst Chinese anaesthesia departments before and after the outbreak of COVID-19

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Editor—Adequate provision of personal protective equipment (PPE) is important in the fight against COVID-19, which is transmitted through droplets, direct contact, and aerosols.[1,2] Anaesthesiologists may need to intubate the trachea of patients with COVID-19, which is a high-risk procedure because of access to the oropharynx and exposure to respiratory secretions that can carry a high viral load. In addition, anaesthesiologists inevitably encounter undiagnosed patients, namely those with false-negative reverse transcription–polymerase chain reaction (RT–PCR)

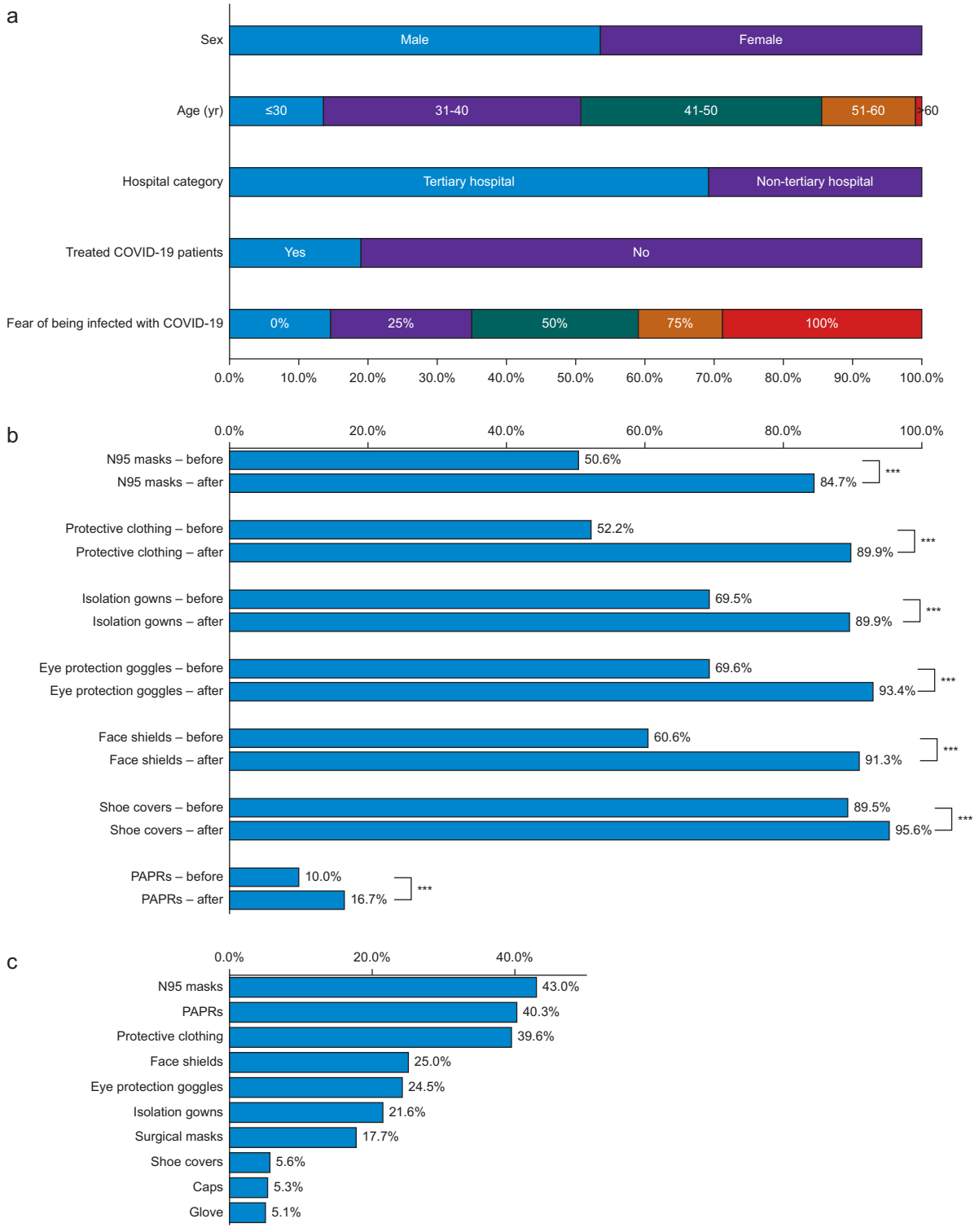

Fig 1. Results of the questionnaire provided to Chinese anaesthesiologists. (a) Respondent characteristics (single choice). (b) Which of the following types of PPE were provided in your department? (multiple choice). (c) What types of PPE were lacking? (multiple choice). Differences before and after the COVID-19 outbreak were evaluated using the χ^2 test for categorical variables. ***P<0.001. PAPR, powered air-purifying respirator; PPE, personal protective equipment.

test results and those who are asymptomatic, which can increase the risk of infection.[3] When performing tracheal intubation, extubation, cardiopulmonary resuscitation (CPR), or tracheotomy on COVID-19 patients, anaesthesiologists require high-level PPE, including N95 mask respirators, goggles, face shields, double gowns, double gloves, protective shoe covers, and even powered air-purifying respirators (PAPRs), for those who cannot be fit tested for an N95 mask and those who have facial hair.[4,5] The cross-infection rate appears to be negatively correlated with the level of PPE, indicating that adequate provision of PPE is essential for the successful management of COVID-19,[6,7] and a lack of PPE is considered a common cause of COVID-19-related deaths among healthcare workers.[8]

In the early days of the COVID-19 outbreak, anaesthesiologists around the world faced PPE shortages. The WHO announced that the COVID-19 outbreak was an international public health emergency on January 30, 2020, which we define as the start of the pandemic. To date, no studies have investigated PPE provision amongst Chinese anaesthesiologists before and after the COVID-19 pandemic began. The purpose of this study was to investigate the provision of PPE in Chinese anaesthesia departments before January 2020 and after the COVID-19 outbreak (April 2021, when the questionnaire was conducted).

A questionnaire was designed by anaesthesia experts, infection control experts, and a statistics expert to investigate the adequacy of the provision of PPE before the outbreak of COVID-19 and after the first 16 months of the pandemic (in April 2021; Supplementary file 1). Participant consent and ethics approval (ethics approval reference: TRECKY2021-057) were obtained. Survey distribution was performed between April 4 and April 24, 2021 by the Perioperative Infective Control Branch of the Chinese Society of Cardiothoracic and Vascular Anaesthesiology. Exclusion criteria were (1) refusal to complete an informed consent form and (2) a response time <180 s.

Of the 1450 respondents who initially participated in the survey, 1225 (84.5%) were included in the final analysis. Our survey showed that 18.9% of anaesthesiologists had treated patients with suspected or confirmed COVID-19. Only 14.5% of Chinese anaesthesiologists were not concerned about infection, whereas the remaining 85.5% had varying degrees of concern (Fig. 1a and Supplementary Table S1). Their concern may have been related to inadequate PPE provision in the early days of the COVID-19 outbreak. Before the COVID-19 outbreak, except for basic protective materials (surgical hats, masks, and shoe covers), more than 30% of Chinese anaesthesiology departments were not equipped with sufficient high-level PPE, including N95 masks, protective clothing, isolation gowns, eye protection goggles, and face shields (Fig. 1b and Supplementary Table S2). On the one hand, healthcare professionals around the world did not foresee such a serious threat and did not realise the need for adequate stocks of PPE. On the other hand, the COVID-19 pandemic has led to an unprecedented global demand for PPE, but the rapid escalation of the pandemic left limited time for replenishment of PPE stocks.

Given that COVID-19 is primarily transmitted by respiratory droplets and aerosols, effective masking is essential to prevent transmission.[9] Compared with before the COVID-19 outbreak, provision of N95 masks in Chinese anaesthesiology departments (50.6% *vs* 84.7%, $P<0.001$) was significantly higher in April 2021. The proportion of departments with available protective clothing (52.2%) and isolation gowns (69.5%) increased to 89.9% ($P<0.001$). Before COVID-19, 60.6% of Chinese anaesthesia departments were equipped with face shields, which increased significantly to 91.3%. Before the outbreak, 10% of Chinese anaesthesiologists were equipped with PAPRs, which increased to 16.7% (Fig. 1b and Supplementary Table S2). This is much lower than for other PPE, and may be attributable to some disadvantages that limit their widespread use including complexity, cost, and production of unfiltered exhaust air.[10] A total of 57.6% of Chinese anaesthesiologists reported that they had experienced deficiencies in the availability of PPE during the COVID-19 pandemic. Among those reporting deficiencies, 43.0% reported deficiencies in N95 masks followed by PAPRs (40.3%), protective clothing (39.6%), face shields (25.0%), and other items (Fig. 1c and Supplementary Table S3).

The COVID-19 outbreak threatens the lives of people and all healthcare workers worldwide. One of the most important limitations of our study is that we focused on only the provision of PPE to anaesthesiologists in China. A majority of Chinese anaesthesiologists used high-level PPE for aerosol-generating procedures (AGPs) after the first wave of the COVID-pandemic, whereas anaesthesiologists in other countries often used lower levels of PPE, in many instances because of supply limitations. Although there may be risk of selection bias, our research shows that PPE provision amongst Chinese anaesthesia departments increased significantly since the outbreak of COVID-19, as the Chinese government fully regulates PPE supply and healthcare workers become more aware of nosocomial infection control. However, there are still some deficiencies that need further improvement.

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Declarations of interest

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Appendix A. Supplementary data

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Learning from individualised variation for evidence generation within a learning health system

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Editor—We read with interest the work of McGinn and colleagues[1] and the accompanying editorial by Moppett[2] highlighting the important issue of variation in care. Both articles describe variation as a problem, particularly where there is good evidence to support a treatment choice, in this case use of peripheral nerve blocks for hip fracture surgery (so-called unwarranted variation).[1,2] However, we believe that for treatments *without* strong underpinning evidence, variation in practice also represents an *opportunity*.

Increasing interest is being paid to the idea of creating Learning Health Systems (LHS) within institutions. The Institute of Medicine created this concept in response to large-scale variation in US healthcare systems.[3] In a LHS, routinely collected patient data are harnessed to generate learning, which is then returned to clinicians to improve future care in what has been described as a 'virtuous cycle of learning'.[4] Efficiency is key: use of routinely collected data via Electronic Health Record Systems (EHRS) helps minimise cost, and computerised Clinical Decision Support (CDS) offers an attractive method of delivering new evidence-based practice recommendations to clinicians.

Even digitally mature institutions have struggled to implement LHS in their entirety, but progress is being made. For example integrated randomisation is now used to test and evaluate quality improvement initiatives.[5] Building on the work of Vickers and Scardino,[6] we believe this approach may also be used to evaluate treatments and enhance CDS. Where evidence exists, the system works to reduce unwarranted variation, but where evidence is lacking, it facilitates integrated randomisation at the point-of-care, enabling learning.[6] This approach is targeted to 'routine care', not investigational or experimental strategies.

Consider some of the routine treatments administered to critically ill patients on a daily basis such as paracetamol for management of fever, postoperative antibiotic prophylaxis, supplemental oxygen therapy, electrolyte replacement, etc. These day-to-day 'micro-decisions' are commonly non-binary, and involve thresholds for starting or stopping treatments, dosing adjustments, and physiological targets. Although we might have some intuition, or even some evidence about these treatments, in the main these comparative effectiveness questions are currently answered by expert