The Swine Flu Triage (SwiFT) study: development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic

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Abstract

The Swine Flu Triage (SwiFT) study: development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic

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Objectives: To use, existing critical care and early pandemic, data to inform care during the pandemic influenza A 2009 (H1N1) pandemic (with a possible use for triage – if the demand for critical care seriously exceeded supply). To monitor the impact of the H1N1 pandemic on critical care services, in real time, with regular feedback to critical care clinicians and other relevant jurisdictions to inform ongoing policy and practice.
Design: Modelling of data and cohort study.
Setting: Modelling – 148 adult, general critical care units in England, Wales and Northern Ireland in the Intensive Care National Audit & Research Centre Case Mix Programme. Cohort study – 192 acute hospitals in England, Wales, Northern Ireland, Scotland and the Republic of Ireland.
Participants: Modelling – 105,397 admissions to adult, general critical care units. Cohort study – 1728 H1N1 pandemic-related admissions referred and assessed as requiring critical care.
Main outcome measures: Modelling – requirement for organ support and acute hospital mortality. Cohort study – survival to the end of critical care.
Results: Modelling – cancelled or postponed, elective or scheduled surgery resulted in savings in calendar days of critical, Level 3 and advanced respiratory care of 17, 11 and 10%, respectively. These savings varied across units. Using routine, physiological variables, the best triage models, for all and for acute respiratory admissions, achieved only satisfactory concordance of 0.79 and 0.75, respectively. Application of the best model on all admissions indicated that approximately 12.5% of calendar days of critical care could be saved. Cohort study – research governance approvals were achieved for 192 acute hospitals, for 91 within 1 day of central research and development approval across the five countries. A total of 1725 cases (562 confirmed) were reported. Confirmed cases were young (mean age of 40 years), had low severity of acute illness on presentation [61% CURB-65 (confusion, urea, respiratory rate, blood pressure, age over 65 years) 0–1], but had long stays in critical care (median 8.5 days) and were likely to be ventilated (77% for median 9 days). Risk factors for acute hospital death were similar to those for general critical care admissions.
Conclusions: SwiFT was rapidly established. Models based on routine physiology suggested limited value for triage. More data and further modelling are warranted. The magnitude of the pandemic did not approach the worst-case scenario modelling, and UK-confirmed H1N1 cases appeared similar to those reported internationally.
Funding: The National Institute for Health Research Health Technology Assessment programme.

Contents

List of abbreviations

ANZICS	Australian and New Zealand Intensive Care Society
APACHE	Acute Physiology And Chronic Health Evaluation
ARDS	acute respiratory distress syndrome
BMI	body mass index
CCMDS	Critical Care Minimum Data Set
CI	confidence interval
CLRN	Comprehensive Local Research Network
CMP	Case Mix Programme
CMPD	Case Mix Programme Database
COPD	chronic obstructive pulmonary disease
CRN	Clinical Research Network
CSO	Chief Scientist Office
CSP	Coordinated System for gaining NHS Permission
CSPU	Coordinated System for gaining NHS Permission Unit
CURB-65	confusion, urea, respiratory rate, blood pressure, age over 65 years
DHSSPS	Department of Health, Social Services and Public Safety
ECMO	extracorporeal membrane oxygenation
FiO_2	fraction of inspired oxygen
GCS	Glasgow Coma Score
H1N1	pandemic influenza A 2009
HPA	Health Protection Agency
HSC	Health and Social Care
HSE	Health Service Executive
ICNARC	Intensive Care National Audit & Research Centre
ICS	Intensive Care Society
IQR	interquartile range
NETSCC	NIHR Evaluation, Trials and Studies Coordinating Centre
NIGB	National Information Governance Board
NIHR	National Institute for Health Research
NRSCC	NHS Research Scotland Coordinating Centre
NRES	National Research Ethics Service
PaO_2	partial pressure of oxygen
PCR	polymerase chain reaction
R&D	research and development
REC	Research Ethics Committee
ROI	Republic of Ireland

RPN	Research Practitioner Network	SSI	site-specific information
SOFA	Sequential Organ Failure Assessment	SwiFT	Swine Flu Triage study
		WHO	World Health Organization

All abbreviations that have been used in this report are listed here unless the abbreviation is well known (e.g. NHS), or it has been used only once, or it is a non-standard abbreviation used only in figures/tables/appendices, in which case the abbreviation is defined in the figure legend or in the notes at the end of the table.

Executive summary

Background

In April 2009, the World Health Organization (WHO) announced confirmed human cases of pandemic influenza A 2009 (H1N1) in Mexico and the USA and raised the pandemic alert level to Phase 4 and subsequently to Phase 5. In May 2009, the first case of human-to-human transmission in the UK was confirmed. In June 2009, the WHO raised the pandemic alert level to Phase 6, the highest level, and the total number of UK cases reached 1000 with the first UK death attributed to H1N1. This advent of a new strain of influenza A, known as swine 'flu, presented an opportunity for research to be commissioned both to inform patient management during the pandemic and, possibly, to inform future pandemics.

Early in the pandemic, it was clear that H1N1 had the potential to cause life-threatening illness. However, the likely impact of the pandemic on the critical care capacity in the UK was unknown. Estimates of the attack, hospitalisation and case fatality rates were extremely uncertain. Based on data to 14 June 2009, the peak requirement for critical care was estimated to be between 0% and 250% of current capacity. These estimates suggested that existing critical care resources, including any surge capacity gained through expansion into Level 2 beds and theatre/recovery settings, could be vastly exceeded.

Excessive demand, where resources are finite, creates an ethical dilemma and triage is required to guide equitable and efficient resource allocation. The rationale for triage should be fair, transparent and meet the principles of distributive justice. Approaches based specifically on models for patients with respiratory infections may be inappropriate as triage decisions need to be made for all patients, not only those with influenza, as a single pool of resources will have to be shared.

Objectives

The aim of the Swine Flu Triage study (SwiFT) was to provide information, early in the pandemic, to guide critical care clinicians and policy-makers. The objectives were:

1. To initiate and co-ordinate an essential research study efficiently, within the NHS, in a pandemic situation.
2. To use both existing critical care and early pandemic data to inform care during the pandemic (potentially to inform triage – if the situation arose where demand for critical care seriously exceeded capacity).
3. To monitor the impact of the H1N1 pandemic on critical care services, in real time, with regular feedback to critical care clinicians and others to inform ongoing policy and practice.

Methods

Objective 1

From late July 2009, in parallel with study design, development and set-up, central and local research governance approvals were required, rapidly, for approximately 220 organisations in five countries – England, Wales, Northern Ireland, Scotland and the Republic of Ireland (ROI).

Objective 2

For the modelling on existing data, consecutive admissions in the Case Mix Programme Database (CMPD), from 1 January 2007 to 31 March 2009, were extracted. The Case Mix Programme (CMP) is the national, comparative outcome audit ongoing in approximately 90% of adult, critical care units in England, Wales and Northern Ireland, co-ordinated by the Intensive Care National Audit & Research Centre (ICNARC). The CMPD has been evaluated as high quality by the Directory of Clinical Databases.

Two approaches were taken to modelling. First, the impact of cancellation/postponement of elective/scheduled surgery, in terms of the percentage of admissions avoided/postponed and the percentage of calendar days of critical care, Level 3 and advanced respiratory support saved, respectively, both overall and across units, was explored. Second, models on two patient

cohorts (all admissions and admissions for acute exacerbations of respiratory illness) were developed using a primary outcome of potentially avoidable admission, critical care required or death. Only routine physiological variables, measured and recorded during the first 24 hours following admission to the critical care unit, were included in the modelling: lowest systolic blood pressure; highest temperature; highest heart rate; highest respiratory rate; and neurological status. The effect of adding lowest partial pressure of oxygen (PaO_2), associated fraction of inspired oxygen (FiO_2) or PaO_2 : FiO_2 ratio; base excess; highest blood lactate; and highest serum urea was explored. Finally, the effect of adding severe comorbidity and/or age was also explored.

Models were fitted using ordered logistic regression, with the primary performance measure being the ability of the model to discriminate between the three outcome categories, assessed by Harrell's concordance statistic. Efron's optimism bootstrap was used to shrink estimates to adjust for overfitting. The effect of using a model to triage patients with low or high scores was explored by modelling potential outcomes for triaged patients.

Objective 3

To monitor the H1N1 pandemic, all acute hospitals in England, Scotland, Wales, Northern Ireland and the ROI were encouraged to participate in SwiFT. All patients, adult or paediatric, were included if they had either confirmed or suspected H1N1 and were referred and assessed as requiring critical care or they were non-H1N1 patients referred and assessed as requiring critical care (under usual/non-pandemic circumstances), but not admitted to a critical care unit in the hospital where referred and assessed. Selected clinical data were collected both from the point of referral and assessment for critical care and daily (by calendar day 00:00–23:59) while receiving critical care. Data were collected on consecutive patients, meeting the inclusion criteria, until SwiFT closed to recruitment on 31 January 2010.

SwiFT data were entered onto a secure, web-based data entry system developed and hosted by the ICNARC. Data collection manuals and forms, definitions and error checking were available for download from or built into the web portal. Weekly reports were submitted to the Department of Health and published on the SwiFT web portal to provide regular reporting to clinicians on the evolving pandemic. The impact of the pandemic on critical care system capacity was assessed through the numbers of patients reported as: transferred to receive critical care in another acute hospital; managed in an extended critical care or non-critical care area; and refused critical care. The impact of the pandemic was also assessed by reviewing data from the CMPD relative to previous years.

Risk factors for death while receiving critical care and for duration of critical care among survivors were assessed by Cox proportional hazards regression models.

Confirmed H1N1 cases in SwiFT were compared with confirmed H1N1 patients from wave 1 of the pandemic and pre-pandemic cohorts of critical care unit admissions with pneumonia from the CMPD, and with published cohorts of critically ill patients with H1N1, internationally.

Results

Objective 1

With respect to SwiFT, the ability to initiate essential research efficiently, within the NHS in a pandemic situation, appeared to be successful. Of the 221 organisations identified across the five countries, submission for local research and development (R&D) approval was achieved for 192 (87%) and approved for 180 (81%). Local R&D approval was both quick and timely for the 150 NHS Trusts in England, with 91 achieving approval within 1 day of central R&D approval. Local R&D approval was similarly quick in Northern Ireland and the ROI, but not as timely. Scotland was slower, but timely relative to Scottish Research Ethics Committee (REC) review. Wales was neither quick nor timely. SwiFT commenced in 192 of 301 (64%) acute hospitals in 158 of 221 organisations. Participation varied across countries: 76% (19 of 25 acute hospitals in Scotland), 72% (154 of 214 acute hospitals in England), 44% (four of nine acute hospitals in Northern Ireland), 38% (6 of 16 acute hospitals in Wales) and 19% (7 of 37 acute hospitals in ROI).

Objective 2

Data were extracted from the CMPD for 105,397 admissions to 148 adult, general critical care units in England, Wales and Northern Ireland from 1 January 2007 to 31 March 2009. Excluding admissions with missing data, 105,380 admissions to 148 units (99.98%) were included in the modelling.

Overall, 25,828 (25%) admissions were associated with elective/scheduled surgery. Cancellation/postponement of these admissions resulted in calendar day savings of 17% for critical care, 11% for Level 3 care, and 10% for advanced respiratory support. There was considerable variation across the 148 units.

After exclusion of admissions associated with elective/scheduled surgery, readmissions and missing data, 74,510 admissions to 148 units were used for the triage modelling, with 15,996 (21%) identified as admissions for acute exacerbations of respiratory illness.

Of all admissions, 19,557 (26%) were classified as 'potentially avoidable', 31,074 (42%) as 'critical care required', and 23,879 (32%) died before discharge from acute hospital. Of admissions with acute exacerbations of respiratory illness, 4098 (26%) were 'potentially avoidable', 5800 (36%) 'critical care required' and 6098 (38%) died before discharge from acute hospital.

The model based on core variables alone produced a concordance of 0.75 (considered 'satisfactory'). Incorporating all additional variables raised this to a maximum of 0.79. The discrimination of the models among admissions with acute exacerbations of respiratory illness was worse, with concordance statistics from 0.71 to 0.75. Among all admissions, the single additional variables that added most discriminatory ability to the core variables were FiO_2 and urea (each raising the concordance to 0.77). Adding severe comorbidity to the model had a negligible effect on concordance; adding age produced a small improvement in concordance, but raises ethical issues.

Using the model based on core variables plus FiO_2 and combining categories from the original fine categorisation to produce a score from 0 to 12 points, the effect of triaging patients with low and high scores was investigated. Triaging patients with scores of 0–3 to temporary critical care areas would result in 57% of critical care unit admissions being diverted, but 58% may subsequently require transfer to the critical care unit, resulting in an overall saving of 11% of critical care unit bed days. Triaging patients with scores of ≥6 to no critical care would divert 14% of critical care unit admissions, saving 15% of bed days; however, 99% of these patients would die, with 30% of the deaths being potentially avoidable if critical care had been provided.

Objective 3

Overall, 1725 confirmed or suspected H1N1 cases and three non-H1N1 cases were reported. Of the 1725 H1N1 cases, 562 (33%) were confirmed to have H1N1, either on initial assessment or during critical care, 899 (52%) tested negative having initially been suspected, and 264 (15%) were neither confirmed nor tested negative. Of the three non-H1N1 cases, one was reported to have been refused critical care owing to lack of available staff and beds, and two received critical care in an extended critical care area. Of the suspected and confirmed H1N1 cases, one was reported to have been refused critical care owing to perceived futility and one owing to lack of available staff and beds, two died while under assessment before transfer to a critical care unit could be arranged, 42 received critical care in an extended critical care area and two in a non-critical care area, and 11 were transferred to receive critical care in another acute hospital. Little impact of the pandemic could be observed by comparing data from the CMPD with previous years.

Confirmed H1N1 cases were younger than those suspected or tested negative (92% aged < 65 years vs 75% and 73%, respectively), more likely to be pregnant (13% of female patients vs 2% and 3%) and more likely to be obese/morbidly obese (25% vs 20% and 13%). Acute severity of illness on initial assessment, as measured by CURB-65 (confusion, urea, respiratory rate, blood pressure, age over 65 years), was low with 61% of confirmed H1N1 cases scoring 0 or 1 points (vs 59% and 46%). Confirmed cases required a median of 8.5 days of critical care (vs 1.3 and 5.4 days) and 79% survived to the end of critical care (vs 69% and 85%).

Risk factors for death while receiving critical care were increasing age, increasing Sequential Organ Failure Assessment (SOFA) score, severe chronic organ dysfunction and being immunocompromised. Pregnancy was associated with a lower risk of death. Increasing duration of critical care among survivors was associated with increasing age up to 50 years, increasing SOFA score, overweight/obesity, pregnancy, confirmed H1N1 on initial assessment, severe chronic organ dysfunction and respiratory presentation.

The age distribution for confirmed H1N1 cases in SwiFT was similar to wave 1 of the pandemic, and considerably younger than pre-pandemic cohorts with viral or bacterial pneumonia. Seventy-seven per cent of confirmed H1N1 cases in SwiFT received advanced respiratory support

for a median of 9 calendar days, similar to wave 1 and pre-pandemic viral pneumonia, but higher than pre-pandemic bacterial pneumonia. Overall duration of critical care was longer for confirmed H1N1 cases in SwiFT than in wave 1 or for pre-pandemic cohorts. Mortality before the end of critical care was lower for confirmed H1N1 cases in SwiFT (21%) than in wave 1 (27%) or pre-pandemic cohorts (26% and 31%, respectively).

The demographics of confirmed H1N1 cases in SwiFT were broadly comparable with cohorts of critically ill H1N1 patients from Australia and New Zealand, Canada, Mexico and Spain. All countries reported a very high proportion of cases aged < 65 years. All except Mexico reported a high proportion of pregnant cases. Mean daily SOFA scores showed a decreasing trend that very closely matched that reported in Canada and was parallel to, but lower than, that reported in Mexico. When split by survival status, the SOFA score increased and then remained high for non-survivors, but decreased in survivors. Mortality at the latest reported follow-up in each country varied from 17% in Australia and New Zealand and Canada to 41% in Mexico. All countries reported long durations of critical care and high requirements for mechanical ventilation.

Conclusions

To everyone's relief, H1N1 did not overwhelm critical care services in the NHS. SwiFT did, however, highlight a number of issues for discussion, some with future implications for health care and priorities for research.

SwiFT indicated that, in some acute hospitals in some of the countries, research could be set up rapidly to provide information, early on in a pandemic, to guide critical care clinicians and policy-makers. However, a number of factors played an important role.

First, the ICNARC's existing capacity, expertise and networks should not be underestimated, even with accelerated procedures for central research and information governance. The experienced staff and established processes and expertise at the ICNARC allowed for the rapid institution of SwiFT and without this 'rolling start' the results of SwiFT may well not have been achieved. If similar capacity, expertise and networks do not exist in other areas, where acute and emergency care will be delivered in a pandemic, the results of SwiFT cannot be considered to be generalisable and there is no room for complacency.

Second, for SwiFT, each of the five countries responded with varying degrees of success in achieving research and information governance approvals. It was clear that the current research governance systems vary among countries and some appeared much better able to react to the need for a rapid study of an evolving health-care issue. Research governance systems appeared more effective in those countries with centralised systems, namely England and Scotland. However, even in the light of recent advances, research governance is often a major barrier to the conduct of research for researchers and the best examples achieved in SwiFT should be the norm, and not the exception, if research that matters to patients is going to be delivered. All should strive to become more able to rapidly process research, especially research that is time-sensitive.

Third, securing local resources appeared to be the main key to participation. It should be noted that it took almost 2 months (following the secure, web-based data entry system going 'live' on 17 September 2009) for comprehensive coverage – SwiFT figures did not equal weekly prevalence figures published by the Health Protection Agency (HPA) (for England) until the week commencing 9 December 2009. It appeared that, even in England where local resources were supposedly available, individuals at the local level did not appear to know how to access them. This may be because the Comprehensive Local Research Network (CLRN) system is new, but anecdotal experience suggests that process and provision are not standard across CLRNs. Improved access to local resources for supporting research (particularly outside England) should be a high priority.

In conclusion, even with the ICNARC's existing capacity, expertise and networks, a Herculean effort and accelerated procedures for governance, the effort and time scale involved in obtaining approvals was unacceptable during a pandemic. There was considerable variation in procedures (including inconsistency in ethics advice between England and Scotland) and in local resources available across the five countries which added to the complexity of the process and inhibited this collaborative research.

Implication for health care 1: Efforts should be continued to further streamline the current research and information governance procedures and access to local resources

required for establishing a research study of benefit to patients, both within and across countries, whether during a pandemic or not.

More generally, a review of the utility and value of information provided (both during and after the pandemic) to clinicians and policy-makers from the commissioned/funded H1N1 research should be conducted. More specifically to SwiFT, whether the balance was achieved correctly, in terms of required data for SwiFT, should be revisited. It is clear from the amount of data that were subsequently entered onto the SwiFT database after the end of the study, that the data requested, specifically the daily data, may have overwhelmed the available resources. In addition, were the reports useful to both clinicians and policy-makers, interaction with the latter indicated such, but clinical feedback should be elicited.

Implication for health care 2: A review of the utility and value of information provided (both during and after the pandemic) to clinicians and policy-makers from the commissioned/funded H1N1 research should be conducted (to include SwiFT) to learn both the generic and specific lessons prior to future pandemics.

SwiFT proposed longer-term follow-up using linkage to national death registration. Unfortunately, such linkage is not currently available using NHS Number. Algorithms for linkage to the NHS Central Register using NHS Number, without the need for patient names, are currently being developed by the NHS Information Centre and planned to be in operation by the end of 2010, recently extended to the end of 2011.

Implication for health care 3: The availability of a system to link using NHS Number should remain a high priority to inform health-care outcomes.

Triage could be required at several steps in the care pathway for patients in a pandemic: first, in primary care, to determine which patients required hospital assessment; second, in the emergency department, to determine which patients needed hospital admission; and third, in hospital, to determine which patients needed critical care. These three triage steps require different triage thresholds and, most probably, different triage models. SwiFT considered only the third step in the care pathway for H1N1 patients – the decision to admit to critical care only and, more specifically, on identifying which patients not to admit when resources are scarce – from among those who would be admitted under usual (non-pandemic) circumstances.

A simple, physiology-based triage model was developed that had only 'satisfactory' concordance. This simple model outperformed CURB-65 among admissions with acute exacerbations of respiratory illness, and seemed to support similar findings from an emergency department cohort. Severity of illness of H1N1 cases, on initial presentation (as assessed by the CURB-65 score), was remarkably low, with 61% of confirmed H1N1 cases scoring 0 or 1 point. According to the Department of Health guidelines drawn up by the British Thoracic Society, British Infection Society and HPA (well in advance of the current pandemic), such patients would be triaged for management at home and not even be admitted to hospital.

Implications for health care 4: CURB-65 appeared an unreliable triage tool.

The utility of a score, derived from the simple, physiology-based triage model, to triage patients for critical care in a pandemic seemed to be minimal. While there may be some scope for using triage models during a pandemic, it seemed clear that these scores/models are not sufficiently discriminatory to be relied upon in isolation, and the resultant savings in terms of critical care unit bed days would not be substantial.

Implication for health care 5: At this time, pandemic planning should not be based on assumptions that a reliable triage tool is available for critical care and the mild nature of the H1N1 pandemic should not induce complacency.

The development of the simple, physiology-based triage model was limited by the available data. In particular, the most extreme physiological measurements from the first 24 hours following admission to a critical care unit, available from the CMPD, were assumed to be representative of pre-admission values that would be used to make a triage decision. Routinely available data on all acute hospital admissions potentially requiring critical care are required to enable a fuller exploration of decision-making around critical care admission. In addition, data on the duration and trajectory of critical illness would enable exploration of triage models to consider earlier discontinuation of critical care for patients initially admitted to critical care.

Implication for health care 6: There is a lack of accurate data to inform usual, non-pandemic, decision-making both around critical care admission and around continuation of critical care treatment, once commenced.

SwiFT successfully collected data on > 1700 critically ill patients who were affected by the H1N1 pandemic, either directly (as a confirmed or suspected H1N1 case) or indirectly through not being admitted to a critical care unit as a result of the pandemic ($n = 3$). The substantial discordance, between the 'reasonable worst-case scenario' and that experienced, underlines the caution that needs to be exercised in accepting modelled data for any new pathogen or for a known pathogen in a new context. To this end, the existing critical care capacity coped – with only a minority of patients experiencing a level of critical care provision lower than in normal, non-pandemic circumstances.

Caution should also be applied in using SwiFT data to model future outbreaks. While SwiFT data would provide reasonably robust estimates for modelling critical care requirements in a subsequent outbreak of an unchanged virus in the UK, it is important to recognise several caveats. First, changes in population immunity (either natural or due to immunisation) may modify disease load, both across the UK and within local communities. Second, these estimates could suffer from substantial inaccuracy if there is a significant change in the antigenicity of the virus. Third, the estimates could be erroneous if applied to a new virus [e.g. H5N1 (avian influenza)]. These considerations make a strong case for even earlier accumulation of data than that achieved by SwiFT in the course of any future epidemic.

Implication for health care 7: Caution needs to be exercised in accepting modelled data for any new pathogen or for a known pathogen in a new context.

The markedly different distribution of ethnicity in confirmed wave 1 H1N1 cases, identified through the CMP, with the distribution of ethnicity in confirmed wave 2 H1N1 cases from SwiFT likely represented early hot spots in the West Midlands and London. The distribution of ethnicity for the latter was similar to that typically observed among critical care admissions more generally.

Implications for health care 8: Caution needs to be exercised in interpretation of data early on in an emerging pandemic and it is important to keep policies and messages up to date.

Research recommendations

Clearly, further research into triage modelling, at each step in the care pathway, is a high priority and specifically important for critical care decision-making. Such research should have two main themes: first, the development and validation of triage models; and second, the potential use of such models for critical care decision-making.

With respect to the first theme, given that triage decisions in a pandemic situation should be made for all patients considered for critical care (and not just those afflicted by the pandemic), data for, and research on, developing and testing the utility of triage models for critical care does not require a pandemic situation. However, to develop such triage models requires the collection of accurate data on all acute hospital admissions potentially requiring critical care to enable a fuller exploration of decision-making around critical care admission and data on the duration and trajectory of critical illness to enable exploration of triage models to consider earlier discontinuation of critical care for patients initially admitted to critical care. In addition to conventional validation of such triage models, validation could also encompass a comparison with subjective clinical decision-making and an assessment of the potential impact of any triage model on future pandemic situations.

Research recommendation 1: Development and validation of triage models to address the research question – what are the best triage models for critical care decision-making?

With respect to the second theme, the use of triage models, there is a need for a much wider public involvement and debate on this issue. This was highlighted in SwiFT, where the North West REC showed considerable disquiet about the potential use of such models without public involvement and debate. It is far better to have public debate on the role of triage modelling in a situation where critical care services become overwhelmed, sooner rather than later, and a pandemic situation is not the best time to be addressing the utility and ethics of triage models in critical care decision-making.

Research recommendation 2: Public involvement and debate around the role of triage modelling in a situation where critical care services become overwhelmed to address the research question – what are the utility and ethics of triage models in critical care decision-making?

Funding

The National Institute of Health Research Health Technology Assessment programme.

Chapter 1

Background to, research governance for and, participation in SwiFT

Introduction

In April 2009, the World Health Organization (WHO) announced the outbreak of confirmed human cases of pandemic influenza A 2009 (H1N1) in Mexico and the USA and raised the pandemic alert level initially to Phase 4 (sustained human-to-human transmission) and subsequently to Phase 5 (widespread human infection). The first two UK cases of H1N1 were confirmed in Scotland.

In May 2009, the first case of human-to-human transmission in the UK was confirmed with laboratory-confirmed cases reported in Northern Ireland and Wales, leading to confirmed cases across the UK.

In June 2009, the WHO raised the pandemic alert level to Phase 6, the highest level (on 11 June 2009), and the total number of UK cases reached 100 with the first UK death attributed to H1N1 (on 15 June 2009).[1]

This advent of a new strain of influenza A, known as swine 'flu, presented an opportunity for research to be commissioned both to inform patient management during the pandemic and, possibly, to inform future pandemics.

The objective of this chapter is to describe the research governance process and report on the ability to initiate and co-ordinate an essential research study efficiently, within the NHS, in a pandemic situation.

Methods

The Intensive Care National Audit & Research Centre (ICNARC) was approached by the National Institute for Health Research (NIHR) Evaluation, Trials and Studies Coordinating Centre (NETSCC), on 12 June 2009, with a view to them commissioning research from the ICNARC. The aim of the proposed research was to provide information, early on in the pandemic, to guide critical care clinicians and policy-makers. The first objective of the proposed research was to use both existing critical care and early pandemic data to inform care during the pandemic (with a possible use for triage – if the situation arose where demand for critical care seriously exceeded capacity). The second objective was to be able to monitor the impact of the H1N1 pandemic on critical care services, in real time, with regular feedback to critical care clinicians and other relevant jurisdictions to inform ongoing policy and practice. The NETSCC encouraged internal prioritisation of this research within the ICNARC (i.e. diversion of any required, senior and junior, research and operational staff from ongoing audit and research projects).

Two ICNARC senior staff members (KMR, DAH) conceived, designed and wrote the Swine Flu Triage study (SwiFT) proposal. An outline proposal for SwiFT was submitted to the NETSCC on 12 June 2009, a full proposal (the first and final draft) with basic costs was submitted on 25 June 2009 and provisional funding was approved by the NETSCC on 9 July 2009. Following detailed response to Board/reviewers' comments and submission of full costs, final funding for SwiFT was approved on 27 July 2009.

In early August 2009, the Chief Investigator (KMR) travelled to Australia to link up with the Australian and New Zealand Intensive Care Society (ANZICS) to learn from their H1N1 experience, its impact on critical care services and their registry.[2,3] A further opportunity for international communication/collaboration occurred between the ANZICS and Canadian registries, with SwiFT (KMR) at the European Society of Intensive Care Medicine meeting in Vienna in October 2009.

Results

Figure 1 summarises the key events.

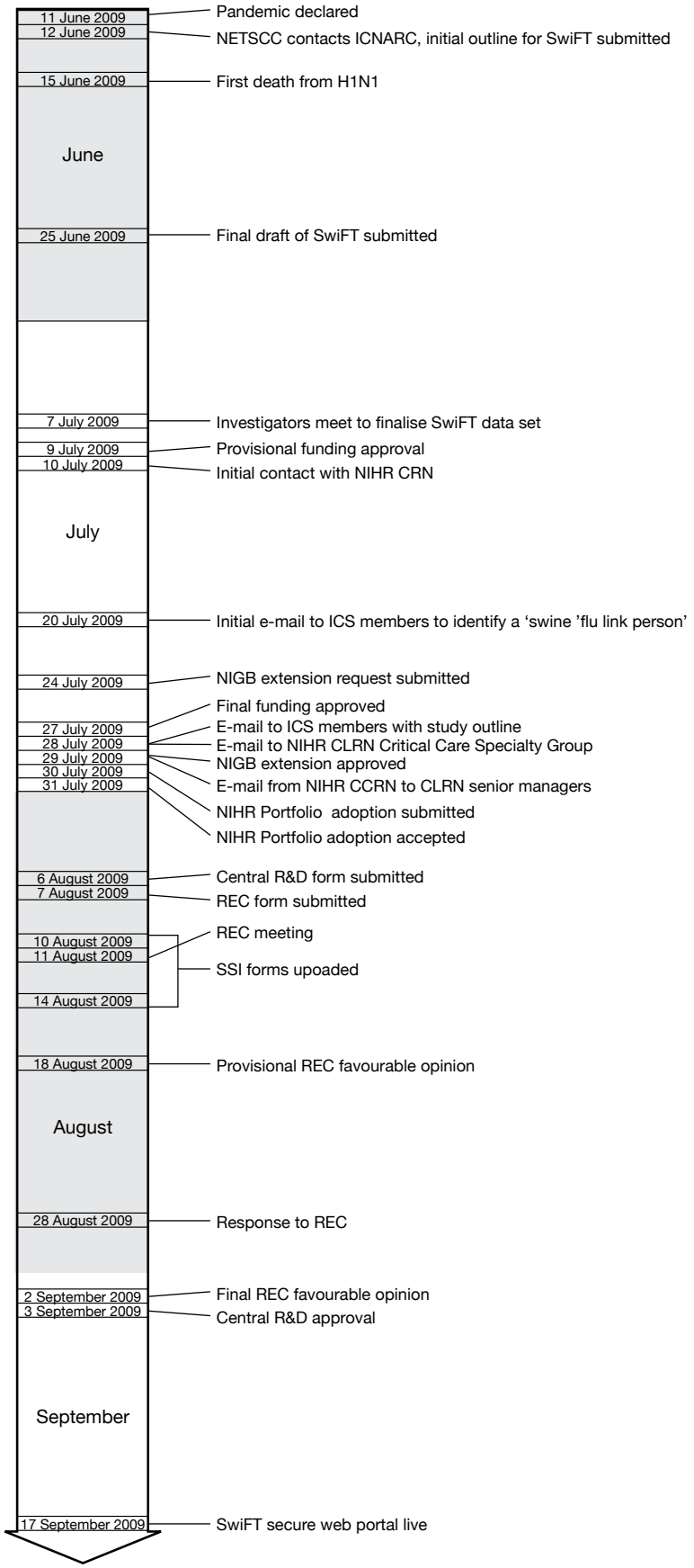

FIGURE 1 *The SwiFT timeline. CLRN, Comprehensive Local Resarch Network; CRN, Clinical Research Network; ICS, Intensive Care Society; NIGB, National Information Governance Board; REC, Research Ethics Committee; SSI, site-specific information.*

Study infrastructure

On 7 July 2009, prior to provisional funding approval, five co-investigators (KMR, DAH, DFMcA, GDP and DKM) met to discuss and agree the proposed data set for primary collection of pandemic-related data. Using the ICNARC's existing international links, data collection forms from Mexico, Canada and Australasia were used to inform the SwiFT data set and to enable compatibility between common variables for international comparison.[2] From this, the final data set specification was developed by the two ICNARC co-investigators (DAH and KMR). Three members of the ICNARC information technology staff immediately commenced development of a secure, web-based, data entry system for SwiFT. Following comprehensive testing by ICNARC staff members, the SwiFT secure, web-based, data entry system went live on 17 September 2009.

In parallel with internal study infrastructure work, central and local research governance approvals were required for approximately 220 organisations (Trusts, Health Boards, etc.) in five countries [England, Wales, Northern Ireland, Scotland and the Republic of Ireland (ROI)]. Five senior members of ICNARC staff, supported by the entire staff, were allocated responsibility for research governance in each of the five countries.

The ICNARC used every opportunity to promote and outline the objectives of SwiFT, either directly as presentations on SwiFT or indirectly by mentioning SwiFT at other ICNARC audit/research study meetings. SwiFT was presented at: the Scottish Intensive Care Society meeting on 4 September 2009; a national critical care meeting on the H1N1 pandemic on 10 September 2009; the twelfth Current Controversies in Anaesthesia & Peri-Operative Medicine meeting (Dingle, Ireland) on 15 October 2009; and a national meeting on infection in critical care on 4 November 2009. SwiFT was also highlighted at data collection training courses for the national clinical audit of adult critical care co-ordinated by the ICNARC, the Case Mix Programme (CMP), and for ongoing ICNARC research studies, Fungal Infection Risk Evaluation (FIRE, 07/29/01) and Risk Adjustment In Neurocritical care (RAIN, 07/37/29) at five courses in September 2009, one in October 2009 and one in November 2009.

Research governance

England

Information governance

Primary data collection for SwiFT was considered, and submitted, as an extension to the National Information Governance Board (NIGB) Ethics and Confidentiality Committee approval for the CMP under Section 251 of the NHS Act 2006. On 24 July 2009, the ICNARC applied for this extension of Section 251 support and this was confirmed for England and Wales on 29 July 2009 (see *Appendix 1*).

Portfolio adoption

Details of clinical research studies which meet specific eligibility criteria are recorded in a database known as the UK Clinical Research Network (UK CRN) Portfolio, which comprises the NIHR CRN Portfolio in England and the corresponding portfolios in Wales, Northern Ireland and Scotland. On 30 July 2009, SwiFT was submitted for adoption by the NIHR CRN Portfolio in England and this was duly granted (reference 7396) on 31 July 2009 (see *Appendix 1*).

Central research and development approval

Once provisional funding was approved, on 10 July 2009, the Chief Investigator (KMR) was contacted directly by the NIHR CRN regarding the expedited process for gaining NHS permissions for national H1N1 research studies using the NIHR Coordinated System for gaining NHS Permission (CSP). On the same day, the Central and East London Comprehensive Local Research Network (CLRN), the original Lead CLRN for SwiFT, led on agreement with the CSP Unit (CSPU) for an appropriate subset of the usual global and local governance checks to be applied. SwiFT was submitted to the NIHR CSP on 31 July 2009, identifying Cambridge University Hospitals NHS Foundation Trust as Lead NHS Trust, and West Anglia CLRN assumed Lead CLRN status. On 6 August 2009, the main research and development (R&D) form was submitted with a list of local collaborators, sourced from the Intensive Care Society (ICS) link person spreadsheet (see *Local research and development approval*), for 125 of 157 acute Trusts in England. Central R&D approval was gained on 3 September 2009 following ethics approval (see *Ethics approval*).

Local research and development approval

In consultation with the CSPU, it was agreed that as SwiFT was a research study, site-specific

information (SSI) forms for all acute hospitals were needed to process through the system. However, it was agreed that one SSI could be written and then duplicated > 150 times – one for each NHS Trust. West Anglia CLRN provided support to assist with the uploading of the local collaborator details, solely amending the NHS Trust for each SSI form. A spread sheet containing all the Local Collaborators was supplied to facilitate West Anglia CLRN supporting this process. SSI forms for 152 NHS Trusts were uploaded in batches from 10 to 14 August 2009.

To expedite the identification of local collaborators, on 20 July 2009, the ICS (the professional organisation for intensive/critical care clinicians) e-mailed all its members requesting details for a 'swine 'flu link person' for each critical care unit. This was followed up, on 28 July, with a second e-mail, drafted by the ICNARC, outlining the objectives and local resourcing for SwiFT and indicating that the details of the link person would be passed to the ICNARC for the purposes of rapidly facilitating the local approval process for SwiFT. The ICNARC contacted the nominated link person (n = 125 of 165 NHS Trusts in England) and included the details in the local collaborators' spread sheet provided to West Anglia CLRN for populating the SSI forms.

Ethics approval

The National Research Ethics Service (NRES) activated an emergency policy allowing Research Ethics Committees (RECs) to consider applications quickly. The REC application for SwiFT in England, Wales and Northern Ireland was expedited by the application, received by the NRES on the 7 August 2009, being diverted to the next available REC meeting – the North West REC on 11 August 2009. Provisional approval was provided on 18 August 2009 highlighting a number of issues, relating to the triage modelling and proposed use of a triage model, which required a detailed response (see *Appendix 1*). This was submitted on 25 August 2009. Final opinion was chased by the ICNARC on 1 September 2009, and a final favourable opinion was received on 2 September 2009 facilitating central R&D approval for SwiFT on 3 September 2009 (see *Appendix 1*).

Local resources

On 28 July 2009, an e-mail was sent to all members of the NIHR CRN Critical Care Specialty Group describing and outlining the objectives of SwiFT. On 29 July 2009, as part of a series of ongoing 'early warning' alerts regarding national H1N1 research studies, the NIHR Comprehensive Clinical Research Network contacted all CLRN clinical directors and senior managers, identifying the NHS support requirements for SwiFT and requesting each CLRN team to review capacity and provide acute hospitals/critical care units support to collect SwiFT data. This included an indication that funding for the data collection exercise could be available from the national contingency, if required (see *Appendix 1*). The Chairperson of the NIHR CRN Critical Care Specialty Group, one of the SwiFT coinvestigators (TSW), facilitated the process of trying to achieve local resources for participating acute hospitals. In addition, SwiFT co-investigators within England (GDP, BLT and DKM) acted as ambassadors for SwiFT within their own CLRNs.

Wales

Local research and development approval

Without a central co-ordinating centre for governance checks in Wales, NHS permission for acute hospitals in Wales had to be gained through their existing processes. The CSPU made the global governance report available to the ICNARC to help facilitate this process. Contact with the senior managers for the three Research Practitioner Networks (RPNs), North Wales, South East Wales and South West Wales, (akin to the CLRNs in England) proved straightforward and the global governance report was shared with them. Senior individuals within the RPNs led and facilitated the identification of acute hospitals/local collaborators and local R&D approval. Despite enthusiasm from the RPNs, the local approval process proved to be slow.

Local resources

Being outside the CLRN system meant that local resources were not available for supporting SwiFT in Wales. Discussions were held with the RPNs regarding availability of local resources. The RPNs did not appear to think local resourcing would be an issue; however, no formal response was provided. It appeared that each RPN approached this on an individual acute hospital/local level.

Northern Ireland

Information governance

As NIGB approval applied only to England and Wales, on 17 August 2009, contact was made with the Department of Health, Social Services and Public Safety (DHSSPS) in Northern Ireland who, in the absence of equivalent legislation, indicated that because SwiFT was very much in the public interest it was acceptable for clinicians to contribute

data without the patient's consent. Following information security checks, Dr Michael McBride, Chief Medical Officer wrote to all Chief Executives of Health and Social Care (HSC) Trusts, on 25 August 2009, indicating that 'whilst individual organisations and clinicians can still make their own decisions about whether or not they wish to contribute patient data to the study, it is the view of the DHSSPS that Northern Ireland should contribute data as the study is very much in the public interest' (see *Appendix 1*).

Local research and development approval

Rather than the expedited SSI form process for England, SSI forms had to be individually generated and checked with each of the five individual NHS Trusts, prior to submission. Along with the dedicated ICNARC staff member, one of the co-investigators (DFMcA) acted as ambassador and facilitated local approvals by helping to identify local collaborators for SwiFT in Northern Ireland.

Local resources

Being outside the CLRN system meant that local resources were not available for supporting SwiFT in Northern Ireland.

Scotland

Information governance

As NIGB approval applied only to England and Wales, on 4 August 2009, contact was made with the Information Governance Lead at the eHealth Directorate in the Scottish Government who, in the absence of equivalent legislation, indicated that each Caldicott Guardian for each individual NHS Health Board would need to be approached about SwiFT. It was acknowledged, by them, that this would be a time-consuming and challenging process with no standardised system or forms. Despite significant investment, centrally and locally, information governance approval proved to be slow.

Local research and development approval

On 28 July 2009, an e-mail was sent to all members of the Scottish ICS describing and outlining the objectives and local resourcing requirements for SwiFT. On 18 August 2009, the NHS Research Scotland Coordinating Centre (NRSCC) agreed to help co-ordinate all the Scottish R&D departments and streamline local approvals for SwiFT. The CSPU provided all the study documents and global checks governance directly to the NRSCC on 8 September 2009. The NRSCC provided R&D contacts for each of the 14 NHS Health Boards. Rather than the expedited SSI form process for England, SSI forms had to be individually generated and checked with each of the 14 individual NHS Health Boards, prior to submission. Along with the dedicated ICNARC staff member, one of the co-investigators (TSW) acted as ambassador and facilitated local approvals by helping to identify local collaborators for SwiFT in Scotland.

As part of the collaborative effort, requested by the NIHR between all national H1N1 research studies, the ICNARC provided the completed SSIs for the 14 Scottish Health Boards, from SwiFT, to facilitate the approval process for a separate genetics study on H1N1 in Scottish critical care units.

Ethics

The REC application for Scotland was received by the Scotland A REC on 24 August 2009, considered at its meeting on 24 September 2009 and a response, received on 28 September 2009, dismissed SwiFT as not requiring ethics approval – 'the Committee was of the opinion that this was audit linked to service development and delivery rather than research, and therefore did not require ethical approval from an NHS research ethics committee' (see *Appendix 1*).

Local resources

Being outside the CLRN system required a different approach to attempt to secure local resources for supporting SwiFT in Scotland. Attempts to secure local resources through the Scottish ICS Audit Group, part of the Information Services Division (NHS National Services, Scotland), were unsuccessful. Contact was made by one of the co-investigators (TSW) with the Director and Deputy Director of the Chief Scientist Office (CSO) which resulted in SwiFT being included in a joint letter from the Chief Medical Officer and the Director of the CSO. The letter, dated 31 August 2009, to all Chief Executives and R&D Directors of NHS Health Boards, REC Chairpersons and Directors of R&D networks, indicated that, for the three studies listed (SwiFT being one), 'it will be very helpful if each Health Board reviewed the capacity of the intensive care units to collect this data and, where such capacity is limited, plan to put in place adequate capacity. If necessary, we expect staff from any CSO NHS infrastructure budget to assist these projects as a priority over their normal responsibilities' (see *Appendix 1*). The CSO committed central support

if this was not identified at the local level. Local investigators attempted to facilitate the process of trying to achieve local resources for participating acute hospitals with their individual, local R&D departments with variable success; some, but not all, committed support. Despite the CSO offer of central support, no additional central funding was requested.

Republic of Ireland

Information governance

As NIGB approval applied only to England and Wales, using existing critical care clinical contacts in the ROI, on 17 August 2009, contact was made with the Health Service Executive (HSE) lead for critical care H1N1 planning and the information communications technology lead on information governance. Detailed information was provided by the ICNARC about data security (physical, logical and network), including a copy of the system level security policy for SwiFT. Though no final verdict was provided, by 8 September 2009, it appeared that there were no major information governance issues to Irish acute hospitals participating in SwiFT. Along with the dedicated ICNARC staff member, a clinical contact, Dr Brian Marsh, acted as ambassador and facilitated HSE and local approvals for acute hospitals in the ROI.

Local research and development approval/ethics

Without a central co-ordinating centre for governance checks in the ROI, local R&D/ethics permission for acute hospitals in the ROI had to be gained through their existing processes, including gaining individual hospital ethics approvals.

Local resources

Being outside the CLRN system meant that local resources were not available for supporting SwiFT in the ROI.

Participation

Local R&D approval was gained at the organisational level (e.g. Trust, Health Board, etc.). Of the 221 organisations identified, submission for local R&D approval was achieved for 192 (87%; see *Figure 2*). The main reason for not submitting for local R&D approval was failure to identify a local collaborator to lead SwiFT. Only in one Trust (Stockport NHS Foundation Trust – Stepping Hill Hospital) did an identified local collaborator (the clinical lead for the critical care unit) actually refuse to participate. Local R&D approval for participation in SwiFT was received for 81% of organisations representing 85% of acute hospitals (*Figure 2*). Local R&D approval converted into actual commencement of data collection in only 64% of the 301 identified acute hospitals.

Local R&D approval was quickest in the ROI, but for only a small number ($n = 9$, 24%) of acute hospitals. England achieved both quick (*Figure 3*) and timelier (*Figure 4*) local R&D approval for a much larger number of NHS Trusts ($n = 150$, 96%) – with 35 English NHS Trusts providing local R&D approval pending central R&D approval (REC approval) and a further 56 providing local R&D approval within 1 day of central R&D approval. Northern Ireland was similarly quick to gain local R&D approval, but for a much smaller number of only five HSC Trusts. Scotland appeared slower for their 11 Health Boards but, as the decision on REC approval for Scotland (i.e. it was ultimately deemed not to be required) did not occur until day 25, local R&D approval was delayed by this fact. The five NHS Trusts in Wales took much longer to gain local R&D approval.

SwiFT commenced in 192 (64%) acute hospitals in 158 organisations (*Figure 5*).

Discussion

Attempting to gain permissions for, and initiate SwiFT in, 221 organisations across five countries was challenging even with the existing networks of, and expertise within, the ICNARC. Despite this, SwiFT only achieved low acute hospital coverage for the ROI (19%), Wales (38%) and Northern Ireland (44%). A question has to be posed as to whether the time attempting to gain permissions/initiate SwiFT in these countries was time well spent? In addition, despite the huge effort of the ICNARC research team to obtain central research and information governance approvals in as short a time scale as possible, local approvals were still slow and the figures illustrate the difficulty in achieving such an ambitious research study, even with the added impetus of a pandemic. A further question has to be posed, therefore, as to whether the timelines for governance achieved in SwiFT are acceptable during a pandemic?

The process of attempting to achieve comprehensive participation of acute hospitals in SwiFT identified a number of facilitators and barriers.

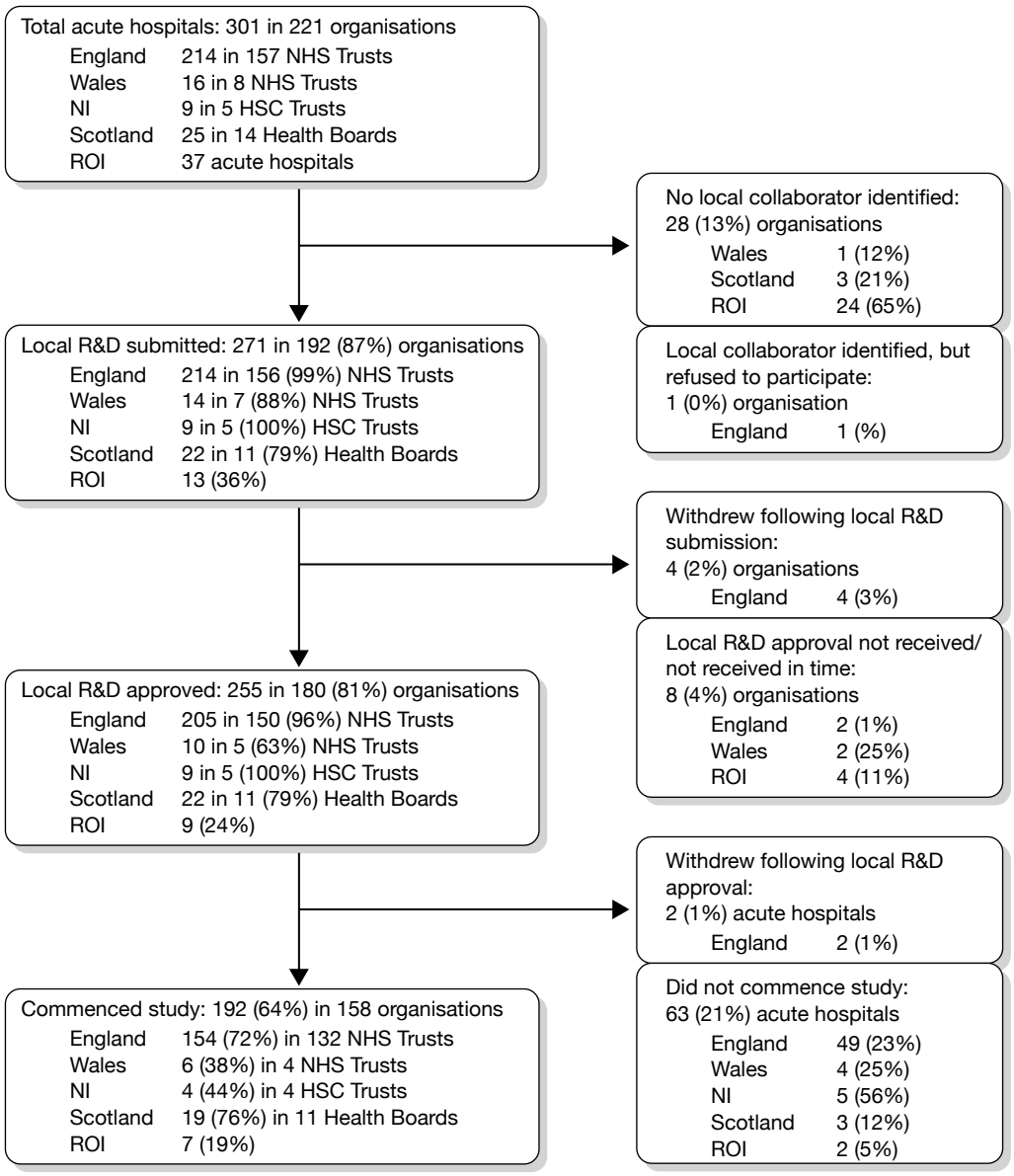

FIGURE 2 *Research governance and participation in SwiFT. NI, Northern Ireland.*

Facilitators

- *Accelerated research governance* The accelerated processes, developed by/for the NIHR CRN, CSPU/CSP, NIGB and NRES/REC, which were activated in England appeared to deliver for SwiFT.[4]
- *ICNARC* The ICNARC had the infrastructure (staff skilled in research design, data set development, web-based data entry development/testing, data validation, analysis and reporting), knowledge (in conducting research, in navigating the research governance system and in critical care), contacts, relationships, trust and track record to conceive, design and deliver SwiFT. In addition, the 'permission' from the NETSCC to divert required ICNARC staff members, without worry of the knock-on effect to other ongoing research studies, allowed for rapid initiation of SwiFT. Despite the existing heavy workload at the ICNARC, ICNARC staff were motivated by the challenge and topical nature of SwiFT and every individual, at every level in the organisation, played a role in supporting its set-up and co-ordination.
- *External support* External support came from four main sources: first, through direct access to individuals with high levels of

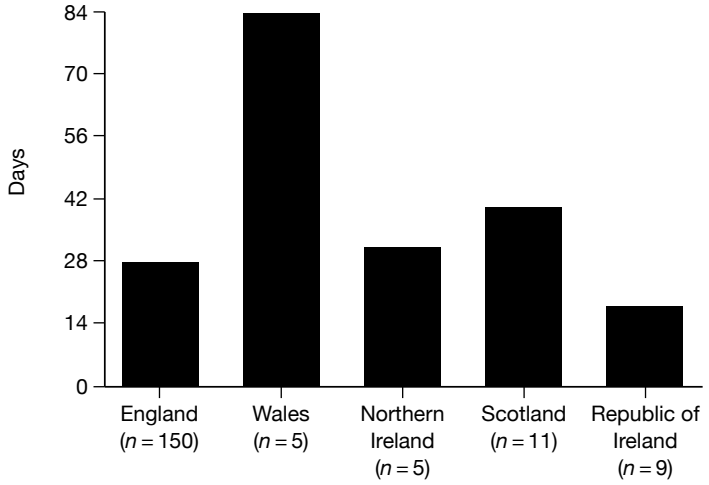

FIGURE 3 *Mean time (days) to obtain local R&D approval for organisations for SwiFT.*

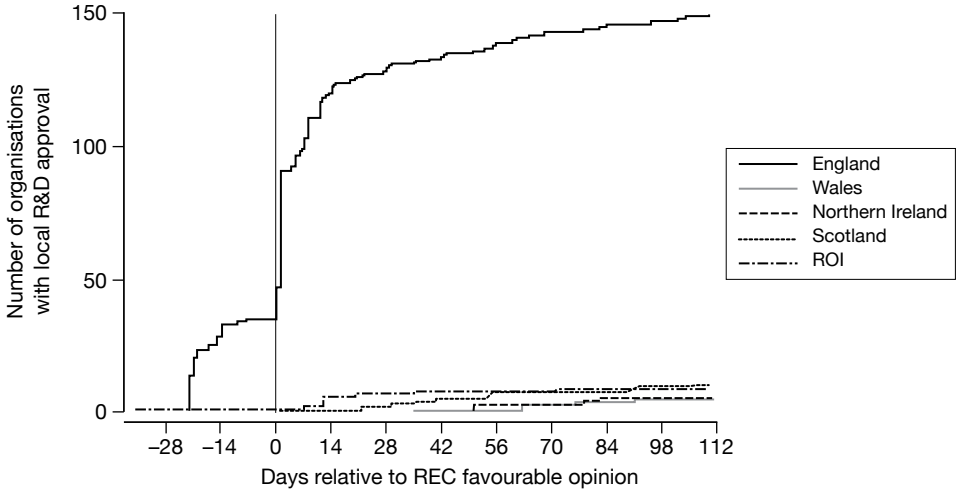

FIGURE 4 *Timeliness of local R&D approval for SwiFT – day 0 indicates central R&D approval for England, Wales and Northern Ireland.*

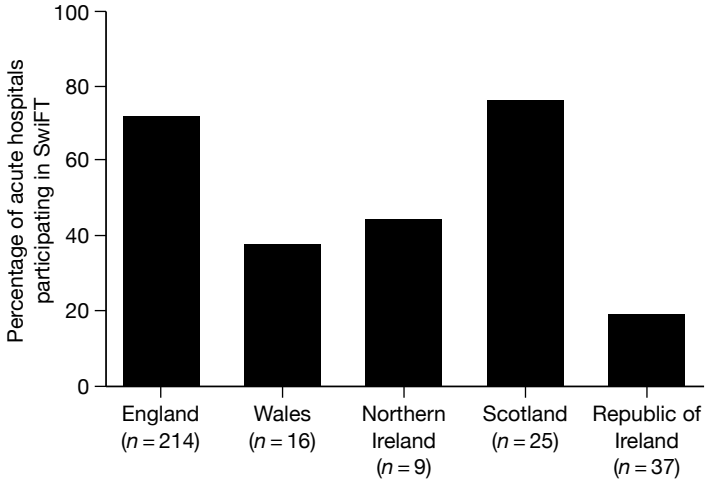

FIGURE 5 *Participation of acute hospitals in SwiFT.*

authority to make decisions in the situation where any potential barriers in the research governance system were identified; second, from the professional organisations, the UK and national Societies, who supported SwiFT; third, from the members of the UK CRN Critical Care Specialty Group and from the directors and leads for Research Management and Governance in the CLRNs (or their direct/indirect equivalents in Wales, Northern Ireland, Scotland and the ROI) who supported acute hospitals in identifying and accessing local resources; and, fourth, from the critical care staff, who rose to the challenge that SwiFT posed.

Barriers

- *Failure to identify local collaborators* With respect to national clinical audit, the ICNARC has a remit solely for adult critical care in England, Wales and Northern Ireland. While the Scottish co-investigator (TSW) helped to facilitate identification of local collaborators in Scotland, the absence of an existing network of contacts in the ROI (and no ROI co-investigator) potentially hindered participation in SwiFT there. Paediatric critical care colleagues were also more reticent about participating owing to insufficient time for the degree of involvement/negotiation being requested by the professional society, the Paediatric ICS, for them to fully endorse and advertise SwiFT.
- *Method of identifying local collaborators* The usual mode of engaging clinicians in a specific research study (i.e. identifying them, engaging their interest and jointly submitting for approval, etc.) was circumnavigated in the interest of speed for SwiFT in England. SSI forms were populated with individuals, probably busy owing to the impending pandemic, whose interest in SwiFT had not previously been identified. While most engaged with the pandemic situation, the speed of the process and the failure to engage up-front did put a few 'noses out of joint'. However, the process followed was not unreasonable and was the only practicable way to get the R&D process 'up and running', in such a large number of acute hospitals, over such a short time frame.
- *Lack of local resources* Accessing local resources to support SwiFT appeared to be much harder in countries outside England, leading to much lower participation in these countries. The exception was Scotland, where participation was higher owing to two apparent reasons – first, the efforts of the Scottish co-investigator (TSW) and second, the existence of a genetic H1N1 study in Scottish critical care units to which SwiFT linked to supply the phenotype data for patients, thus avoiding duplicate data requirements.
- The existence of the CLRN system enhanced participation in England; however, following local R&D approval, the main reason cited for not participating appeared to be the absence of local resources. This appeared to be as much down to a lack of knowledge of acute hospital staff in how to access these resources, possibly due to the newness of the system and the staff's newness to research, than to a refusal to provide the resources.
- *Lack of an integrated, centralised system for research governance* The relative effort required to gain approvals for acute hospitals outside England was immense. While Scotland had a centralised system for R&D approvals, gaining information governance clearance for each NHS Health Board from each Caldicott Guardian proved very time-consuming; one individual could hold up a number of acute hospitals ready to start for some considerable time.
- *Other competing activities* The European Society of Intensive Care Medicine initiated a European H1N1 registry which was promoted to the UK critical care community. The UK Extracorporeal Membrane Oxygenation (ECMO) Consortium had their own H1N1 initiative and acute hospitals providing ECMO tended not to, or only partially, participate in SwiFT. The Paediatric Intensive Care Audit Network was pooling data on paediatric critical care unit admissions with H1N1.

The next chapters present the results of SwiFT.

Chapter 2

Exploration of potential physiological models to triage patients requiring critical care using existing (pre-pandemic) data

Introduction

In the earliest stages of the pandemic, it was clear that H1N1 had the potential to cause life-threatening illness. However, the likely impact of the pandemic on critical care capacity in the UK was unknown. Estimates of the attack rate, hospitalisation rate and case fatality rate were extremely uncertain.

In the light of these uncertainties, based on data available to 14 June 2009, Ercole *et al*.[5] attempted to model the likely impact of an H1N1 pandemic, lasting 12 weeks, on critical care in England. Based on disease severity data from the USA[6] and from Mexico,[7] attack rates of 61% for age < 15 years and 29% for age ≥15 years, with a hospital admission rate from 0% to 2%, were assumed. The latter exceeded the then current hospital admission rate (0%) for the first 752 cases in England and, yet, the US hospital admission rate at this time was 9%, 95% confidence interval (CI) 7% to 12%. The assumed impact was that 36% of hospital admissions would require critical care and that 50% of these would require ventilatory support. Using age-stratified data for the English population, the peak requirement for critical care for H1N1 cases was estimated to be between 0% and 250% of current capacity (assumed to be the sum of total adult Level 3 beds and total paediatric intensive care beds). Peak ventilator usage was estimated to be between 0% and 120% of current capacity (assumed to be equal to the number of beds). Focusing solely on H1N1 cases, these estimates suggested that existing critical care resources, including any surge capacity gained through expansion into Level 2 beds and theatre/recovery settings, could be vastly exceeded.

Excessive demand, where resources are finite, creates an ethical dilemma and many emergency plans apply a utilitarian approach (to do the most good for the greatest number), sacrificing individual benefits for the greater good.[8] However, the Committee on Ethical Aspects of Pandemic Influenza, established by the Chief Medical Officer in 2006, rejected this as the driving principle for ethical decision-making, favouring instead a principle of 'equal concern and respect'.[9] Within this framework, a key component of treatment decisions is fairness ('everyone *with an equal chance of benefitting* from an intervention should have an equal chance of receiving it'[9]). In this situation, the principles of biomedical ethics and international law dictate that triage be used to guide equitable and efficient resource allocation and that the rationale for triage should be fair and transparent and meet the principles of distributive justice – the fair distribution of scarce resources.[8,10]

Triage could be required at several steps in the care pathway for patients with H1N1: first, in primary care, to determine which patients required hospital assessment; second, in the emergency department, to determine which patients needed hospital admission; and third, in hospital, to determine which patients needed critical care. These three triage steps would require different triage thresholds and, most probably, different triage models. It is important to note that SwiFT only considered the third step in the care pathway for H1N1 patients.

For obvious reasons, no triage models specifically designed in the context of H1N1 existed. However, the threat of H5N1 avian influenza had initiated the development of triage models.[11–16] These existing, proposed models for triage of patients considered for critical care were based on: expert opinion;[11] existing severity scores for either general critical care, e.g. the Sequential Organ Failure Assessment (SOFA),[12,13] or pneumonia, e.g. CURB-65 (confusion, urea, respiratory rate, blood pressure, age 65+ years);[14] or developed and/or validated using small, single-centre populations of patients presenting to emergency departments with either community-acquired pneumonias[15] or suspected infection.[16]

Many existing triage models relied on data relating to chronic health conditions,[11–15] which may be difficult to assess reliably during the peak of a pandemic. In addition, many models used laboratory parameters,[11–14] the measurement of which is resource-intensive and may delay a triage decision.

Guidance from the Department of Health, released at the start of the H1N1 outbreak, recognised that there was no universally accepted system available for triage in this context.[17] The guidance focused on the use of a SOFA-based system, but acknowledged that further research in this area was required and that, in the event that a more robust tool was developed, the guidance would be updated.

An ideal triage tool needs to be simple enough to be applied quickly and consistently during the peak of the pandemic (which may not be the case for SOFA-based tools),[13] but also be complex enough to be 'scaleable', i.e. the decision criteria could be adjusted in order to match demand against capacity.[10] It also needs to be able to match inevitable staff shortages (from staff sickness as well as increased demand) and suboptimal staff expertise (arising from the need to redeploy staff to critical care), against the actual clinical demands posed by patients.

Approaches based specifically on models for patients with respiratory infections (e.g. CURB-65) may be inappropriate, as triage decisions would need to be made for all patients considered for critical care and not only those with H1N1, as a single pool of resources would have to be shared among all patients.[10,12]

In a pandemic, triage decisions would need to be made for patients who would be admitted to the critical care unit under usual (non-pandemic) circumstances. The decision problem being considered in this chapter was therefore: of the patients admitted to a critical care unit in usual (non-pandemic) circumstances, was it possible to develop a triage model that could reliably divide patients into the following three groups:

1. Those who required a low degree of organ support and might be safely managed in non-critical care areas or temporary critical care areas (e.g. theatre/recovery areas upgraded to provide basic critical care facilities).
2. Those who required a significant degree of organ support within a critical care unit but, with such support, would survive to leave acute hospital.
3. Those who, despite full critical care support, would not survive to leave acute hospital and for whom, in pandemic circumstances, critical care may need to be denied on the grounds of futility.

Methods

Selection of data

The CMP is the national, comparative audit of patient outcomes from adult, critical care units in England, Wales and Northern Ireland, co-ordinated by the ICNARC. The CMP is a voluntary performance assessment programme using high-quality clinical data to facilitate local quality improvement through routine feedback of comparative outcomes and key quality indicators to clinicians/managers in adult critical care units. The CMP recruits predominantly adult, general critical care units, either standalone intensive care units or combined intensive care/high-dependency units. Currently, approximately 90% of adult, general critical care units in England, Wales and Northern Ireland are participating in the CMP.

The CMP-specified data are recorded prospectively and abstracted retrospectively by trained data collectors according to precise rules and definitions, set out in the ICNARC CMP Dataset Specification. Data collectors from each unit are trained prior to commencing data collection, with retraining of existing staff or training of new staff also available. CMP training courses are held at least four times per year.

The CMP-specified data are collected on consecutive admissions to each participating critical care unit and are submitted to the ICNARC quarterly. Data are validated locally, on data entry, and then undergo extensive central validation for completeness, illogicalities and inconsistencies, with data validation reports returned to units for correction and/or confirmation. The validation process is repeated until all queries have been resolved and then the data are incorporated into the CMP Database (CMPD).

The CMPD has been evaluated according to the quality criteria of the Directory of Clinical Databases (www.icapp.nhs.uk/docdat/) and scored highly.[18]

All admissions in the CMPD to adult, general critical care units in England, Wales and Northern

Ireland from 1 January 2007 to 31 March 2009, collected to Version 3.0 of the ICNARC CMP Dataset Specification, incorporating the Department of Health Critical Care Minimum Data Set (CCMDS),[19] were extracted.

Impact of cancelled/postponed elective and scheduled surgery

Critical care unit admissions that could potentially be avoided by the cancellation/postponement of elective and scheduled surgery were identified by the following criteria:

1. admissions direct from theatre with a classification of surgery as 'elective' or 'scheduled'
2. all subsequent admissions during the same hospital stay of patients identified from criterion (1)
3. admissions for pre-surgical preparation.

The impact of cancellation/postponement of these admissions was estimated by:

- the percentage of admissions avoided/postponed
- the percentage of calendar days of critical care saved
- the percentage of calendar days at Level 3 saved
- the percentage of days of advanced respiratory support saved,

both overall and across units.

Exclusions

For the purpose of developing the triage models, the following admissions were excluded:

- admissions associated with elective/scheduled surgery (as defined above)
- admissions missing all basic vital signs (temperature, systolic blood pressure, heart rate and respiratory rate)
- admissions missing status at ultimate discharge from acute hospital
- readmissions of the same patient within the same acute hospital stay.

Patient cohorts

Models were developed using both the following two cohorts:

(a) all admissions, except those excluded based on the criteria listed above
(b) admissions for acute exacerbations of respiratory illness, defined by the presence of any of the following conditions as the primary or secondary reason for admission to the critical care unit:
   - acute respiratory distress syndrome (ARDS) ['non-cardiogenic pulmonary oedema (ARDS)']
   - pneumonia ('bacterial pneumonia'; 'viral pneumonia'; 'pneumonia, no organism isolated')
   - acute exacerbations of chronic airways disease ['chronic obstructive pulmonary/airways disease (COPD/COAD)'; 'chronic obstructive pulmonary disease with acute lower respiratory infection'; 'chronic obstructive pulmonary disease with acute exacerbation, unspecified'; 'emphysema'; 'asthma attack in new or known asthmatic'].

Note: complete identification of such cases was dependent on the recording of one of the above conditions as either the primary (mandated) or secondary (optional) reason for admission. Primary and secondary reasons for admission to the critical care unit are coded using the ICNARC Coding Method,[20] which was developed specifically for the CMP. It is a five-tiered, hierarchical method for coding reasons for admission or underlying conditions in critical care consisting of the type of condition (surgical/non-surgical), body system, anatomical site, pathological/physiological process and specific condition.

The case mix of admissions in the two cohorts was described by their age, sex, source of admission to the critical care unit, Acute Physiology And Chronic Health Evaluation (APACHE) II Acute Physiology Score and APACHE II score,[21] ICNARC Physiology Score,[22] and, for cohort B, CURB-65 (new onset confusion; urea $> 7\,\text{mmol}\,\text{l}^{-1}$; respiratory rate ≥ 30 breaths per minute; systolic blood pressure < 90 mmHg or diastolic blood pressure ≤ 60 mmHg; age ≥ 65 years).[23]

Triage modelling

The primary outcome for the triage models was an ordinal outcome on the following scale:

1. *Potentially avoidable admission*: admission did not receive advanced respiratory support, advanced cardiovascular support, renal support, neurological support or liver support (as

defined by the CCMDS)[19] at any time during the stay in the critical care unit and survived to leave acute hospital.
2. *Critical care required*: admission survived to leave acute hospital but was not a 'potentially avoidable admission' (i.e. received advanced respiratory support, advanced cardiovascular support, renal support, neurological support and/or liver support at any time during the stay in the critical care unit).
3. *Death*: admission did not survive to leave acute hospital.

The following routine physiological variables, termed 'core variables', measured and recorded during the first 24 hours following admission to the critical care unit, were included in the modelling:

- highest temperature (central or, if no central available, non-central)
- lowest systolic blood pressure
- highest heart rate
- highest respiratory rate
- neurological status, using Glasgow Coma Score (GCS) to approximate AVPU (Alert, Voice, Pain, Unresponsive) categories of Alert (GCS 15), Voice (GCS 10–14), Pain (GCS 7–9) and Unresponsive (GCS 3–6)[24] and a separate category for patients for whom GCS could not be assessed owing to sedation.

In addition, the effect of adding the following variables, termed 'additional variables', to the model (alone or in combination) was explored:

- lowest partial pressure of oxygen (PaO_2), associated fraction of inspired oxygen (FiO_2) or $PaO_2 : FiO_2$ ratio
- base excess (calculated from the arterial blood gas with the lowest pH and from the lowest haemoglobin)
- highest blood lactate
- highest serum urea.

The physiological variables were divided into categories using small intervals at round values (e.g. multiples of 5 or 10, dependent on the scale of the variable).

Finally, the effect of incorporating severe comorbidity and/or age into the triage models was explored by selecting the preferred model based on physiological variables only and adding severe comorbidity (either in five individual organ systems or overall) and age (as a linear term).

Models were fitted using ordered logistic regression, with the primary performance measure of interest being the ability of the model to discriminate between the three outcome categories. Discrimination was assessed by Harrell's concordance statistic, a natural generalisation of the area under the receiver operating characteristic curve for binary logistic regression.[25] A concordance of 1 corresponds to perfect discrimination – that is, for any pair of admissions with different outcomes, the admission with the worse outcome will have the higher score. A concordance of 0.5 corresponds to discrimination that is no better than chance. Concordance values > 0.7 are generally considered to be 'satisfactory', > 0.8 'good' and > 0.9 'excellent'.[26] The standard error of the concordance statistic was calculated using a jack-knife procedure adjusted for clustering of the outcome at the unit level. As the models were developed and validated on the same data set, performance measures may be subject to 'shrinkage'. Efron's optimism bootstrap (with 200 bootstrap samples) was used to estimate the optimism in the concordance due to overfitting.[27]

The effect of using a model to triage patients with low or high scores was explored by modelling potential outcomes for triaged patients. For patients with low scores triaged to temporary critical care areas, it was assumed that those with outcomes classified as 'potentially avoidable admissions' would be managed safely in the temporary critical care area and discharged alive, but that those classified as 'critical care required' or 'death' would subsequently be transferred to the critical care unit. The number of bed days saved by this approach was therefore the bed days of critical care occupied by the diverted admissions that were 'potentially avoidable'. For patients with high scores triaged to no critical care, it was assumed that those with outcomes classified as 'potentially avoidable admissions' would survive without critical care, but that those classified as 'critical care required' or 'death' would die, with the 'critical care required' group representing deaths that were potentially avoidable if more critical care capacity had been available.

All analyses were performed using STATA/ version 10.1 (StataCorp LP, College Station, Texas, USA). The concordance statistic was calculated using the somersd package.[28]

Results

Selection of data

Data were extracted from the CMPD for 105,397 admissions to 148 adult, general critical care units in England, Wales and Northern Ireland from 1 January 2007 to 31 March 2009. Excluding admissions whose last known status was still in the critical care unit ($n = 7$), admissions missing the date of discharge from, or death in, the critical care unit ($n = 2$), and admissions with inconsistencies in CCMDS data ($n = 8$) left 105,380 admissions to 148 units (99.98%) included in the analysis.

Impact of cancelled/postponed elective and scheduled surgery

Overall, 25,828 (24.5%) admissions were associated with elective/scheduled surgery. These consisted of 23,548 admissions from theatre, 1240 subsequent readmissions, and 1040 admissions for pre-surgical preparation. Cancellation/postponement of these admissions would result in saving 17.0% of calendar days of critical care, 10.9% of calendar days of Level 3 care and 9.9% of calendar days of advanced respiratory support.

There was considerable variation in admissions associated with elective/scheduled surgery across the 148 critical care units (*Figure 6*). The median number of admissions in the available data from these units for elective/scheduled surgery was 611 [interquartile range (IQR) 368 to 973; and range 44 to 1966, respectively] and the median number of calendar days of critical care delivered was 3490 (IQR 2280 to 5526; and range 326 to 12,361, respectively).

Exclusions

After exclusion of admissions associated with elective/scheduled surgery, a total of 79,552 admissions remained. For triage modelling, the following additional admissions were excluded: admissions missing status at ultimate discharge from acute hospital ($n = 867$, 1.1%); readmissions to the critical care unit within the same acute hospital stay ($n = 3475$, 4.4%); admissions missing all basic vital signs ($n = 700$, 0.9%). A total of 74,510 admissions to 148 adult, general critical care units remained for analysis.

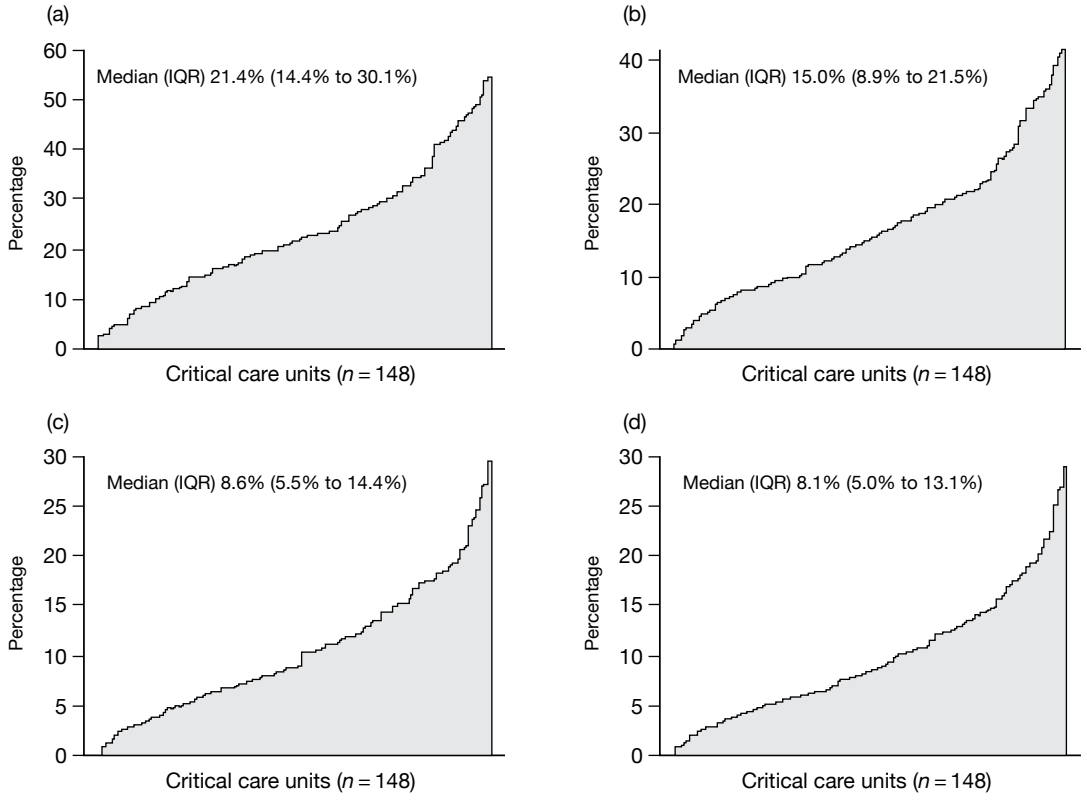

FIGURE 6 *Variation across 148 adult, general critical care units in (a) the percentage of admissions prevented, and (b) calendar days of critical care, (c) Level 3 care and (d) advanced respiratory support saved by cancellation/postponement of elective/scheduled surgery.*

Patient cohorts

Of 74,510 admissions included in the analysis, 15,996 (21.5%) admissions were identified as admissions for acute exacerbations of respiratory illness. A brief summary of the case mix of all admissions and of admissions for acute exacerbations of respiratory illness is presented in *Table 1*.

Triage modelling

Of 74,510 admissions, 19,557 (26.2%) were classified as 'potentially avoidable', 31,074 (41.7%) as 'critical care required', and the remaining 23,879 (32.0%) died before discharge from acute hospital. Of 15,996 admissions with acute exacerbations of respiratory illness, 4098 (25.6%) were classified as 'potentially avoidable', 5800 (36.3%) as 'critical care required' and 6098 (38.1%) died before discharge from acute hospital.

The concordance statistics for triage models based on the core variables only, and core variables plus one or more additional variables, are shown in *Table 2*. Data on blood lactate were only available for 57,551 admissions to 118 units (12,144 with acute exacerbations of respiratory illness), therefore models incorporating blood lactate were restricted to these data. The model based on core variables alone produced a concordance of 0.75 (which may be considered 'satisfactory'). Incorporating all additional variables raised this to a maximum of 0.79. The discrimination of the models among admissions with acute exacerbations of respiratory illness was generally worse, with concordance statistics ranging from 0.71 to 0.75. Among all admissions, the single additional variables that added most discriminatory ability to the core variables were FiO_2 and urea (each raising the concordance to 0.77). Among admissions with acute exacerbations of respiratory illness, the addition of urea marginally outperformed the addition of FiO_2 (concordance 0.74 vs 0.73), supporting the presence of urea within the CURB-65 score for community-acquired pneumonia. However, the difficulty in obtaining a urea value quickly

TABLE 1 *Patient cohorts for triage modelling*

	All admissions (*N* = 74,510)	**Acute exacerbations of respiratory illness (*N* = 15,996)**
Age, mean (SD)	58.8 (19.7) years	61.1 (17.8) years
Sex, *n* (%)		
Female	33,246 (44.6)	7414 (46.3)
Male	41,264 (55.4)	8582 (53.7)
Source of admission to the critical care unit, *n* (%)		
Emergency department/not in hospital	24,239 (32.5)	4794 (30.0)
Theatre (following emergency/urgent surgery)	17,876 (24.0)	539 (3.4)
Ward or intermediate care	27,474 (36.9)	9032 (56.5)
Other critical care unit	4921 (6.6)	1631 (10.2)
APACHE II[a]		
Acute physiology score, mean (SD)	13.3 (6.6)	14.2 (6.3)
APACHE II score, mean (SD)	17.4 (7.5)	18.9 (7.2)
ICNARC physiology score, mean (SD)	19.7 (9.8)	21.8 (9.4)
CURB-65, *n* (%)		
0	–	420 (2.6)
1	–	2645 (16.5)
2	–	4507 (28.2)
3	–	5147 (32.2)
4	–	2682 (16.8)
5	–	595 (3.7)

SD, standard deviation.
a Excluding admissions aged < 16 years and admissions staying < 8 hours in the critical care unit.

TABLE 2 *Concordance statistics for physiology-based triage models*

Variables in model	Concordance (95% CI)	
	All admissions (*n* = 74,510)	**Acute exacerbations of respiratory illness (*n* = 15,996)**
Core variables[a] only	0.752 (0.746 to 0.757)	0.712 (0.703 to 0.721)
Core variables plus...		
… PaO_2	0.761 (0.754 to 0.767)	0.722 (0.713 to 0.730)
… FiO_2	0.770 (0.763 to 0.776)	0.728 (0.719 to 0.736)
… PaO_2 : FiO_2	0.766 (0.760 to 0.772)	0.728 (0.719 to 0.736)
… Base excess	0.763 (0.757 to 0.770)	0.722 (0.713 to 0.731)
… Urea	0.771 (0.766 to 0.776)	0.738 (0.730 to 0.747)
… FiO_2 and urea	0.784 (0.778 to 0.790)	0.747 (0.738 to 0.755)
… FiO_2, base excess and urea	0.786 (0.781 to 0.792)	0.749 (0.741 to 0.758)
Core variables only[b]	0.751 (0.744 to 0.757)	0.712 (0.702 to 0.722)
Core variables plus…		
… Blood lactate[b]	0.766 (0.761 to 0.772)	0.715 (0.707 to 0.724)
… FiO_2, base excess, urea and blood lactate[b]	0.791 (0.786 to 0.796)	0.752 (0.743 to 0.760)

a Highest temperature, lowest systolic blood pressure, highest heart rate, highest respiratory rate and neurological status.
b *n* = 57,551 admissions to 118 units (12,144 with acute exacerbations of respiratory illness) with blood lactate data.

enough to use as the basis for a triage decision has previously been identified as a limitation of using CURB-65 for triage.[15] It was proposed, therefore, that the most practical physiology-based triage model should be based on the core variables plus FiO_2. Applying Efron's optimism bootstrap to this model indicated that the anticipated degree of shrinkage when applying this model in future populations was small. The estimated optimism (95% CI) in the concordance was 0.00054 (0.00036 to 0.00073) for all admissions and 0.00099 (0.00055 to 0.00144) for admissions with acute exacerbations of respiratory illness. Adjusted estimates of the concordance for this model were therefore 0.769 and 0.727, respectively.

Incorporating severe comorbidity into the triage model based on core variables and FiO_2 resulted in a negligible improvement in concordance (*Table 3*). Incorporating age into the triage model, in addition to comorbidity, produced a small improvement in concordance to 0.788 for all admissions and 0.761 for admissions with acute exacerbations of respiratory illness.

A potential simple, physiology-based, triage model is described in *Table 4*. This model produced a score with a range from 0 to 12. The distribution of the score and associated outcomes are illustrated in *Figure 7*. As a result of combining adjacent categories from the original fine categorisation to produce this score, there was some loss of discrimination, resulting in a concordance statistic for the score of 0.754 (95% CI 0.747 to 0.760) among all admissions and 0.713 (95% CI 0.705 to 0.721) among admissions with acute exacerbations of respiratory illness. By comparison, the concordance statistic for CURB-65 among admissions with acute exacerbations of respiratory illness was 0.680 (95% CI 0.671 to 0.688).

The effect of using this model to triage patients with low and high scores is shown in *Tables 5* and *6*, respectively. Although the strategy of diverting patients with a low score to temporary critical care areas may seem appealing in terms of initially diverting a relatively large proportion of admissions from the critical care unit, the effect on bed occupancy is much less as the 'potentially avoidable admissions' generally had short stays in the critical care unit. The upper limit of any such strategy would be to save the 12.5% of bed days occupied by 'potentially avoidable admissions' overall. By comparison, although triaging patients with high scores diverts a much smaller proportion of admissions, the effect in critical care unit bed

TABLE 3 *Concordance statistics for triage models incorporating severe comorbidity and/or age*

Variables in model	Concordance (95% CI)	
	All admissions (*n* = 74,510)	**Acute exacerbations of respiratory illness (*n* = 15,996)**
Core variables[a] and FiO_2 only	0.770 (0.763 to 0.776)	0.728 (0.719 to 0.736)
Core variables and FiO_2 plus…		
…severe comorbidity in five separate organ systems[b]	0.773 (0.767 to 0.779)	0.734 (0.725 to 0.742)
…severe comorbidity (any/none)	0.773 (0.767 to 0.779)	0.734 (0.725 to 0.742)
…severe comorbidity in five separate organ systems[b] and age (linear)	0.788 (0.783 to 0.794)	0.761 (0.753 to 0.768)
…severe comorbidity (any/none) and age (linear)	0.788 (0.783 to 0.793)	0.760 (0.753 to 0.768)

a Highest temperature, lowest systolic blood pressure, highest heart rate, highest respiratory rate and neurological status.
b Cardiovascular (New York Heart Association Functional Class IV), respiratory (permanent shortness of breath with light activity due to pulmonary disease or receiving home ventilation), renal (requirement for chronic renal replacement therapy), hepatic (biopsy-proven cirrhosis, portal hypertension or hepatic encephalopathy), immunocompromised (due to disease or therapy).

TABLE 4 *Potential simple physiology-based triage score incorporating core variables and FiO_2*

	Score			
	0	**1**	**2**	**3**
Systolic blood pressure (mmHg)	95+	75–94	60–74	<60
Temperature (°C)	36.5+	36–36.4	< 36	
Heart rate ($minute^{-1}$)	< 130	130+		
Respiratory rate ($minute^{-1}$)	12–35	< 12 or 36+		
Neurological status	A, GCS 15	V, GCS 10–14	P,[a] GCS 7–9	U, GCS 3–6
FiO_2	0.21	0.22–0.49	0.50+	

A, alert; P, pain; U, unresponsive; V, voice.
a Or unable to assess neurological status owing to effects of sedation.

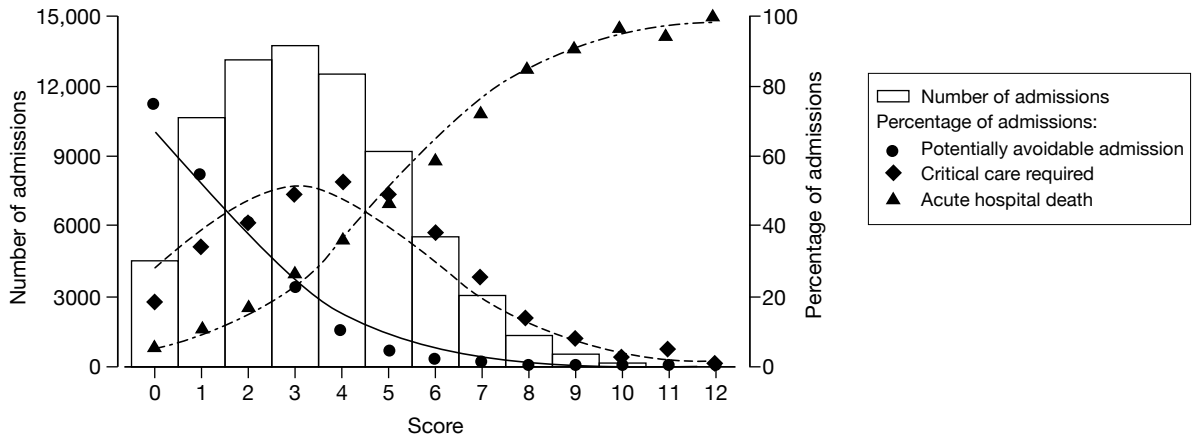

FIGURE 7 *Distribution of the score (bars) and relationship with outcomes (line: predicted by model; points: observed) for a 12-point triage score based on core variables plus FiO_2.*

TABLE 5 *Effect of triaging patients with low scores to temporary critical care areas*

Scores on which triage occurs	Percentage of admissions diverted	Potential outcomes for diverted admissions			Percentage of critical care unit bed days saved[a]
		Critical care unit admission avoided	Subsequent admission to critical care unit – survives	Subsequent admission to critical care unit – dies	
0	6.0%	74.5%	18.8%	6.6%	1.8%
0–1	20.3%	60.6%	29.5%	9.9%	5.1%
0–2	38.0%	51.5%	34.9%	13.6%	8.8%
0–3	56.5%	42.1%	39.8%	18.1%	11.1%

a Bed days for diverted admissions having a critical care unit admission avoided.

TABLE 6 *Effect of triaging patients with high scores to no critical care*

Scores on which triage occurs	Percentage of admissions diverted	Potential outcomes for diverted admissions			Percentage of critical care unit bed days saved[a]
		Likely survivor	Avoidable death	Unavoidable death	
10–12	0.3%	0.0%	3.0%	97.0%	0.1%
9–12	1.1%	0.1%	6.8%	93.1%	0.4%
8–12	2.9%	0.1%	11.4%	88.4%	1.7%
7–12	6.9%	0.7%	20.1%	79.2%	5.7%
6–12	14.4%	1.5%	30.0%	68.5%	15.4%

a Bed days for all diverted admissions.

days saved is greater as these patients had longer stays in the critical care unit. However, the savings in terms of bed days would be small and the cost of these savings would potentially be a substantial number of avoidable deaths.

Discussion

A simple, physiology-based, triage model was developed that had 'satisfactory' concordance for distinguishing between outcome categories. The model outperformed CURB-65 among admissions with acute exacerbations of respiratory illness. These results seem to support findings from an emergency department cohort that CURB-65 is an unreliable triage tool in this setting.[29] Some of the poor performance of CURB-65 could be attributed to the fact that it was developed to triage patients for admission to hospital (a different triage step in the care pathway to that considered in SwiFT).

It is unsurprising that the performance of the simple, physiology-based triage model was not better as, even using much more detailed laboratory and diagnostic data available within the critical care unit, complex risk prediction models produce concordance estimates in the range 0.82–0.87 for distinguishing hospital survivors from non-survivors.[22,30] Even with this higher level of concordance it has been suggested that such risk models should not be routinely relied on, in isolation, for making life and death decisions for individual patients.[31]

The development of the simple, physiology-based, triage model was limited by the available data in the CMPD. In particular, the most extreme physiological measurements from the first 24 hours following admission to a critical care unit were assumed to be representative of pre-admission values that would be used to make a triage decision. Using these more extreme physiological values from a wider time period could falsely enhance the apparent performance of the model. Addition of severe comorbidity had only a small effect while the addition of age had a moderate effect, though the concordance of the model was still only satisfactory.

The incorporation of age into a triage model potentially raises ethical concerns.[8]

The utility of a score, derived from the simple, physiology-based, triage model, to triage patients for critical care in a pandemic seems to be minimal. Under the most extreme conditions considered, i.e. triaging patients with a score of 0–3 to a temporary critical care area, admitting patients with a score of 4 or 5 and denying critical care to patients with a score of ≥6, a saving of only 26.5% of critical care bed days would be achieved. However, for every 100 patients triaged:

- 57 patients would initially be managed in a temporary critical care area, but 33 of these would subsequently require transfer to the critical care unit and the subsequent effect of this delayed transfer on critical care resource utilisation and outcome cannot be quantified
- 29 patients would be admitted to the critical care unit as usual
- 14 patients would be denied critical care, and of these, four patients would die who would otherwise have survived if admitted to the critical care unit.

While there may be some scope for using such scores for triage to critical care during a pandemic, it seems clear that: (1) these scores are not sufficiently discriminatory to be relied upon in isolation; and (2) the resultant savings in terms of critical care unit bed days would not be substantial. More data are required to explore this in further detail. Data on all acute hospital admissions potentially requiring critical care would be required to enable a fuller exploration of decision-making around critical care admission. Data on the duration and trajectory of critical illness would enable exploration of triage models to consider earlier discontinuation of critical care for patients initially admitted to critical care.

In conclusion, it must be recognised that triage may be required at several steps in the care pathway for patients with H1N1 and each step probably requires different triage models. SwiFT focused on the decision to admit to critical care only and, more specifically, on identifying which patients not to admit, when resources are scarce, from among those who would be admitted under usual (non-pandemic) circumstances. Given this, the failure of the simple, physiology-based triage model to reliably identify patients who are unlikely to benefit from critical care suggests that: (1) further research into triage methods, at each step in the care pathway, should be a high priority; and (2) pandemic planning should not be based on assumptions that a reliable triage tool is available for any step.

Chapter 3

The impact of H1N1 on critical care in the UK

Introduction

The objective of the main phase of SwiFT was to provide regular reporting to policy-makers and to clinicians to guide immediate policy and practice on the use of critical care services during the pandemic. This chapter describes the impact of the pandemic on critical care services and patients' care and outcomes.

Methods

Coverage

All acute hospitals in England, Scotland, Wales, Northern Ireland and the ROI were encouraged to participate in SwiFT. As soon as each site completed governance checks, data were collected on consecutive patients meeting the inclusion criteria until SwiFT closed to recruitment on 31 January 2010 (in consultation with the Department of Health). At the end and following completion of recruitment, the local collaborator at each site signed a final declaration, confirming the period of recruitment and indicating that all consecutive, eligible patients had been recruited, or reporting any exceptions. The overall coverage of SwiFT across sites in England was assessed by comparing data from SwiFT with weekly prevalence figures for critical care compiled and published by the Health Protection Agency (HPA) from daily situation report data submitted to the Department of Health from individual NHS Trusts in England. The coverage of SwiFT, relative to the pandemic as a whole, was estimated by comparing the numbers of confirmed H1N1 cases recruited in SwiFT with the total numbers of intensive care unit and high-dependency unit admissions reported by the Department of Health and the devolved administrations.[1]

Inclusion criteria

All patients (adult or paediatric) were included in SwiFT if they were either:

- confirmed or suspected pandemic H1N1 patients referred and assessed as requiring critical care; or
- non-H1N1 patients referred and assessed as requiring critical care (under usual/non-pandemic circumstances), but not admitted to a critical care unit in the hospital where referred and assessed.

Data collection

Selected clinical data were collected from both the point of referral and assessment for critical care and daily (calendar day 00:00–23:59) while receiving critical care. Daily data collection continued until either tested negative for suspected H1N1 cases or critical care ended for confirmed H1N1 cases (*Figure 8*). Confirmed H1N1 was defined as tested positive for H1N1 by real-time polymerase chain reaction (PCR) or viral culture from upper respiratory swabs *or* tracheobronchial aspirate. Suspected H1N1 was defined as any patient believed to have H1N1 and managed as such. Tested negative for H1N1 was defined as at least one negative real-time PCR from *both* upper respiratory swabs *and* tracheobronchial aspirate. Date, time and status when critical care ended were collected for all suspected H1N1, confirmed H1N1 and non-H1N1 cases.

Assessment data included event (date, time and location of assessment); sociodemographic (age, sex and ethnicity); body composition [ranges of body mass index (BMI)]; pregnancy status; H1N1-related (status, vaccine status, antivirals and presentation); chronic organ dysfunction (mild/severe); responsiveness (Alert/Voice/Pain/Unresponsive, confusion); vital signs (temperature, blood pressure, heart and respiratory rate); oxygenation (oxygen saturation and fraction of inspired oxygen); and selected results (base excess, blood lactate, serum urea and creatine kinase). All elements to calculate the CURB-65 assessment of severity of pneumonia score[23] were included.

Daily data included H1N1-related (status and antivirals); organ support (by body system including type of ventilatory support); selected drugs; responsiveness (lowest GCS); vital signs (lowest systolic blood pressure and highest heart rate); oxygenation (lowest PaO_2 with associated FiO_2); selected results (highest bilirubin, lowest

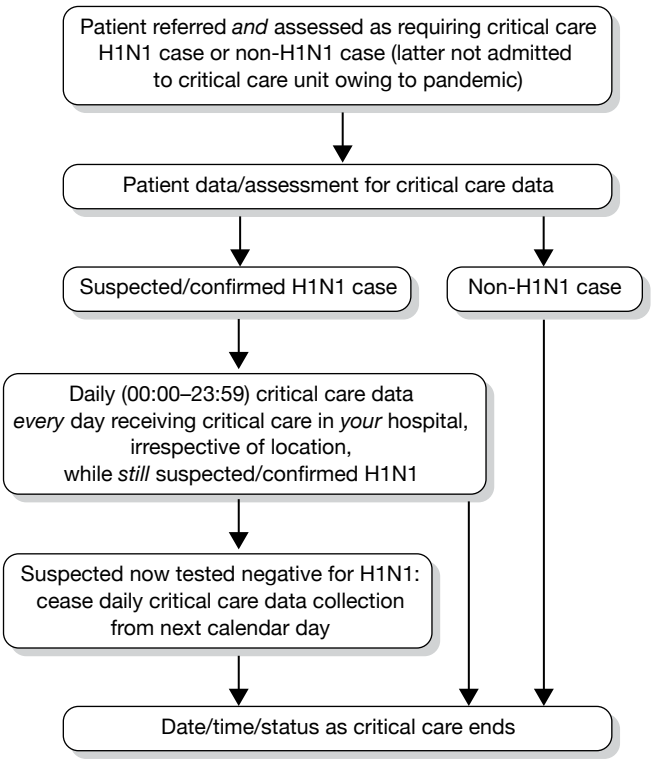

FIGURE 8 *Overview of data collection for SwiFT.*

platelet count, highest blood lactate and highest creatinine) and fluids (total urine output and overall balance). All elements to calculate the SOFA score[32] were included.

SwiFT data were entered onto a secure web-based data entry system developed and hosted by the ICNARC. Data collection manuals and forms (see *Appendix 2*), definitions (either as help text or as answers to frequently asked questions) and error checking were either available for download or built into the design of the web portal.

Reporting during the pandemic

Once a suitable sample size of cases had been accrued in the SwiFT database, weekly reports were circulated to policy-makers and to critical care clinicians. Key policy-makers receiving the reports included the Department of Health Pandemic Flu Team, Chief Medical Officer, Scientific Advisory Group for Emergencies, Pandemic Influenza Clinical and Operational Group, Director General responsible for Pandemic Influenza, Director of NHS Flu Resilience, Scientific Pandemic Influenza sub-group on Modelling Operational group, Influenza Clinical Information Network, and Swine Flu Critical Care Clinical Group. To maximise access to all clinicians, the weekly reports were uploaded onto the SwiFT web portal to provide regular updates on the evolving pandemic.

The content of the reports was developed initially by two SwiFT co-investigators (KMR, DAH) and circulated to key policy-makers and clinicians for comment and input.

System capacity

The impact of the H1N1 pandemic on critical care system capacity was assessed by: the numbers of patients refused critical care (owing to either perceived futility or the lack of available staff and/or beds); the numbers of patients managed in extended critical care areas or in non-critical care areas; and the numbers transferred to receive critical care in another acute hospital.

The wider impact of the H1N1 pandemic was assessed by evaluating data from the CMPD for the year April 2009 to March 2010 compared with the previous 2 years. Data were extracted for all adult, general critical care units with complete data for the entire 3-year period, and the following were plotted for each month: total number of admissions; number of admissions

direct from theatre following elective or scheduled surgery; number of admissions from recovery only (representing use of recovery as an extended critical care area); number of admissions transferred to a critical care unit in another hospital; and the number of these transfers that were for non-clinical reasons (i.e. not for more specialised critical care or repatriation).

Description of cases

Suspected/confirmed H1N1 cases were classified, for presentation, into the following three categories:

- *Confirmed:* H1N1 confirmed either on initial assessment or at any time during critical care.
- *Suspected:* H1N1 suspected on initial assessment, but never confirmed nor tested negative.
- *Tested negative:* H1N1 suspected on initial assessment, but never confirmed and subsequently tested negative.

The patients identified in these three categories were described and compared by the following factors.

Patient demographics were described by age on initial assessment, ethnicity, sex, pregnancy status and body composition. Ethnicity was reported by collapsing the ethnic categories, as used in the 2001 UK census, into the following five groups: white (A, B, C); mixed (D, E, F, G); Asian or Asian British (H, J, K, L); black or black British (M, N, P); other ethnic groups (R, S); or not stated (Z). Pregnancy status was recorded as currently pregnant, recently pregnant (within the past 42 days), or neither. Body composition was assessed, either objectively by calculation of BMI or subjectively, and categorised as: very thin (BMI $< 16\,kg\,m^{-2}$); thin (BMI 16–18.5 $kg\,m^{-2}$); acceptable weight (BMI 18.6–24.9 $kg\,m^{-2}$); overweight (BMI 25–29.9 $kg\,m^{-2}$); obese (BMI 30–39.9 $kg\,m^{-2}$); or morbidly obese (BMI $\geq 40\,kg\,m^{-2}$).

Chronic health status was described by reported chronic organ dysfunction of respiratory, cardiovascular, renal, hepatic and neurological systems (classified as either moderate or severe) and by the presence of immunocompromise (due to disease or therapy). For respiratory and cardiovascular organ dysfunction, moderate dysfunction was defined as outpatient management and severe dysfunction as severe impairment in activities of daily living. For renal organ dysfunction, moderate dysfunction was defined as outpatient management and severe dysfunction as requiring chronic renal replacement therapy. For hepatic organ dysfunction, moderate dysfunction was defined as compensated liver disease and severe dysfunction as decompensated liver disease or awaiting transplantation. For neurological organ dysfunction, moderate dysfunction was defined as some impairment in activities of daily living and severe dysfunction as severe impairment in activities of daily living.

Reported presentation was classified as: viral pneumonitis/ARDS; secondary bacterial pneumonia; exacerbation of airflow limitation, e.g. COPD or asthma; or another intercurrent illness with H1N1 (coded with the ICNARC Coding Method[20]).

Acute severity on initial assessment was described by the CURB-65 score,[23] which is a severity assessment score for community-acquired pneumonia. It consists of five points, one point each for the presence of new onset confusion, urea $> 7\,mmol\,l^{-1}$, respiratory rate of ≥ 30 breaths $minute^{-1}$, low systolic ($< 90\,mmHg$) or diastolic ($\leq 60\,mmHg$) blood pressure, and age ≥ 65 years. Acute severity on the first calendar day of critical care was summarised by the SOFA score.[32] The SOFA score is a scoring system summarising the degree of organ dysfunction with 0–4 points assigned to each of: respiratory ($PaO_2 : FiO_2$ and mechanical ventilation); cardiovascular (mean arterial pressure and administration of vasopressors); renal (creatinine and urine output); hepatic (bilirubin); neurological (GCS); and coagulation (platelets), giving a total score ranging from 0 to 24.

For patients receiving critical care, the duration of critical care was calculated from the date and time critical care commenced to the date and time critical care ended. The duration of critical care was displayed graphically by cumulative frequency plots and summarised by the median and mean. The survival status for the three groups was summarised at the end of critical care within the original hospital.

Performance of triage models

The performance of the simple physiology-based triage model developed was assessed among patients with confirmed or suspected H1N1 at initial assessment for critical care and compared with that of CURB-65. The outcome variable

differed slightly from that used to derive the model, as follow-up was available only to the end of critical care and not to ultimate discharge from acute hospital. This may therefore be considered to represent the performance of the model under the assumption that all those patients surviving the critical care episode would go on to leave acute hospital alive. [Note: data from all adult, general critical care admissions in the CMP indicate that, of those who survive to leave the critical care unit, a further 8% die before discharge from acute hospital.]

Risk factors for death and duration of critical care

For patients receiving critical care within the original hospital, risk factors for death, while receiving critical care within the original hospital, were assessed with a Cox proportional hazards regression model. The outcome for the model was the time to death while receiving critical care. Patients ending critical care or lost to follow-up (owing to incomplete daily data) were treated as censored. The potential risk factors included in the model were: age (non-linear relationship fitted using restricted cubic splines); sex; pregnancy status; ethnicity (white vs non-white); H1N1 status (confirmed vs suspected) on initial assessment; reported presentation; location of assessment (emergency department vs other); chronic organ dysfunction (any severe vs any moderate vs none); being immunocompromised; and SOFA score on first calendar day of critical care.

For patients surviving to the end of critical care within the original hospital, risk factors for longer duration of critical care were assessed with a Cox proportional hazards model. The outcome for the model was time to end of critical care. Deaths were excluded and patients lost to follow-up were treated as censored. The same potential risk factors were explored as listed for time to death while receiving critical care (above).

Results

Coverage

SwiFT received central research governance approval on 3 September 2009 and the secure, web-based, data entry system went live on 17 September 2009. A total of 192 acute hospitals participated in SwiFT, including 154 of 214 acute hospitals in England (72%), 6 of 16 in Wales (38%), 4 of 9 in Northern Ireland (44%), 19 of 25 in Scotland (76%) and 7 of 37 in ROI (19%). Owing to the very variable time taken to complete local governance checks, participation increased over time.

Final declaration forms were received from the local collaborators representing 188 (98%) of the 192 acute hospitals that commenced recruitment. Of the returned declarations, 64 (34%) indicated that not all paediatric cases were included, owing to a misunderstanding of the inclusion criteria and only recording data for patients admitted to the adult critical care unit ($n = 59$), owing to lack of resources ($n = 3$) or owing to cases being missed ($n = 2$). Capture of all confirmed and suspected H1N1 cases was reported as complete for 178 (95%) acute hospitals, with 10 reporting potentially incomplete capture owing to either lack of resources ($n = 3$) or cases being missed ($n = 7$). Capture of non-H1N1 cases affected by the pandemic was reported as complete for 170 (90%), with 18 reporting potentially incomplete capture owing to a misunderstanding of the inclusion criteria ($n = 11$), to lack of resources ($n = 5$), or to cases potentially being missed ($n = 2$).

The number of acute hospitals participating by week, of the 174 acute hospitals admitting adult patients and returning completed final declaration forms confirming periods of continuous screening for eligible cases, is shown in *Figure 9* (four paediatric hospitals that actively participated in SwiFT have been excluded from this figure owing to the lack of complete capture of paediatric cases in other hospitals). Extrapolating from these figures indicated overall coverage of 39% (46% in England) of acute hospitals with adult critical care facilities for the period 3 September 2009 to 31 January 2010. *Figure 10* shows the number of new adult cases by week compared with the number of participating hospitals.

Initial coverage of SwiFT in England was low compared with the weekly prevalence figures published by the HPA. However, by the end of SwiFT, a greater number of prevalent cases were identified from SwiFT than were reported by the HPA (*Figure 11*).

All cases, including those added to the portal after the close of recruitment, were included in this report. Overall, 1,725 confirmed or suspected H1N1 cases and three non-H1N1 cases were reported in SwiFT (*Figure 12*). Of these, 268 (16%) cases and 2,098 (19%) daily assessments (of a final total of 11,322) were added to the web portal after 31 January 2010, when SwiFT closed to new cases.

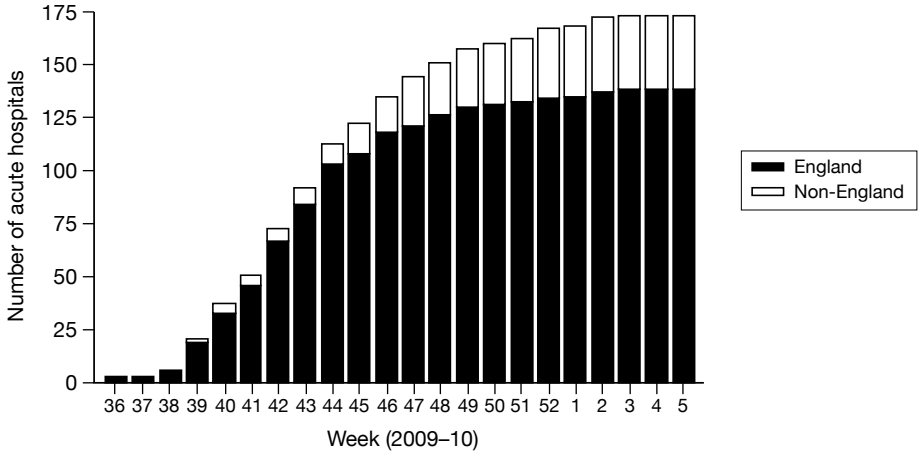

FIGURE 9 *Number of acute hospitals admitting adult patients participating in SwiFT by week (week 36 = week commencing 31 August 2009).*

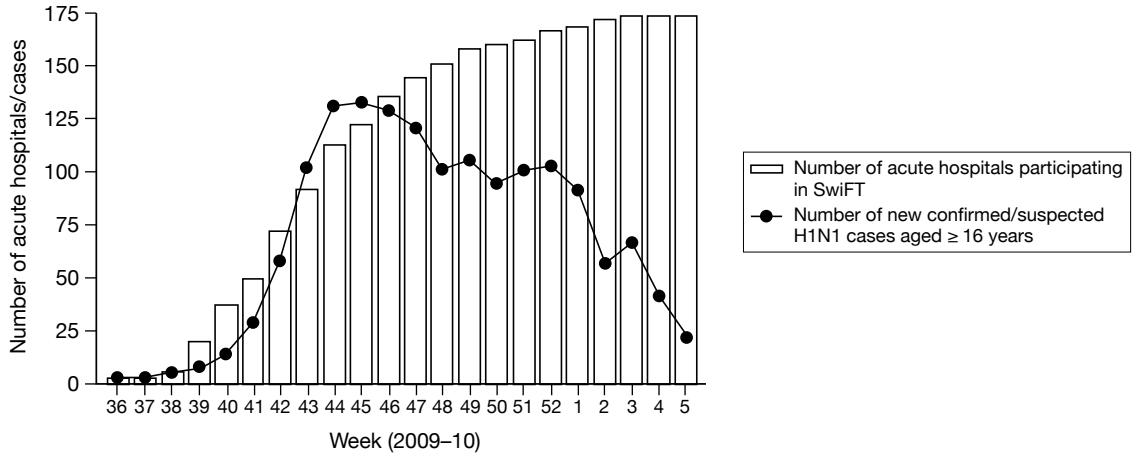

FIGURE 10 *Number of new confirmed/suspected H1N1 cases (aged ≥ 16 years) in SwiFT, by week, compared with number of participating acute hospitals (week 36 = week commencing 31 August 2009).*

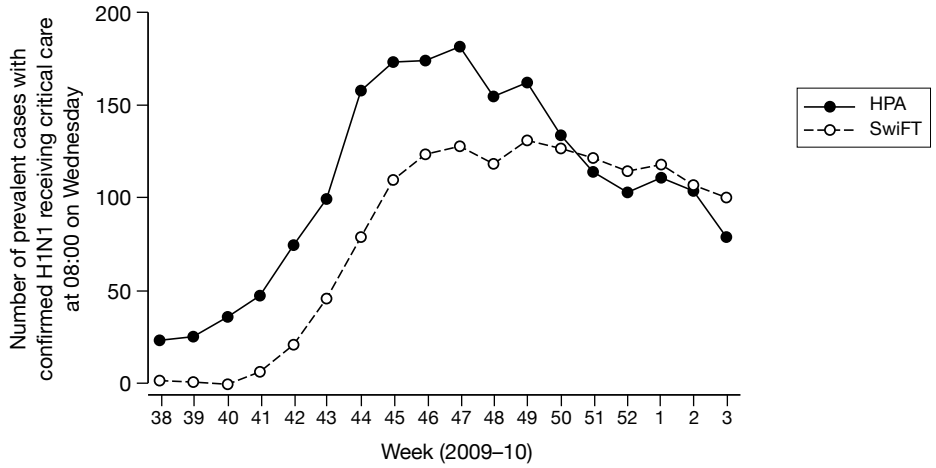

FIGURE 11 *Weekly reported prevalent cases of confirmed or suspected H1N1 receiving critical care in England from SwiFT compared with HPA figures (week 38 = week commencing 14 September 2009).*

Of the 1725 H1N1 cases, 562 (33%) were confirmed to have H1N1, either on initial assessment or at any time during critical care, 899 (52%) tested negative for H1N1 having initially been suspected, and 264 (15%) suspected cases were neither confirmed nor tested negative. Of 1679 cases assessed with information on location available, 603 (36%) assessments took place on the ward, 506 (30%) took place in the emergency department, 521 (31%) took place in a critical care or extended critical care area, and 49 (3%) took place in other locations.

Relative to the total number of admissions with H1N1 to intensive care units and high-dependency units throughout the entire pandemic (waves 1 and 2 combined), as reported by the Department of Health and devolved administrations, 474/2326 (20%), 6/64 (9%), 6/50 (12%) and 60/187 (32%) were recorded in SwiFT from England, Wales, Northern Ireland and Scotland, respectively. Total figures for the ROI were not available.

Reporting during the pandemic

The first weekly report from SwiFT was submitted to the Department of Health on 13 November 2009 and was uploaded to the SwiFT web portal on 16 November 2009. Reports continued weekly until the final weekly report on 5 February 2010. An example of a weekly report is included in *Appendix 3*. Weekly dialogue was maintained with the Deputy Director of the Department of Health Pandemic Flu Team and additional ad hoc analyses were conducted on specific issues (e.g. on pregnancy, on vaccination, on obesity, etc.), as required. In addition, the SwiFT Chief Investigator presented an update on the impact of the pandemic on critical care services to the Swine Flu Critical Care Clinical Group on 11 December 2009.

A comparison of results using those data available (i.e. entered) by end of week 47 with all data up to week 47 (i.e. including those data subsequently entered) indicated no difference in the substantive results provided in the weekly reports.

System capacity

Of the three non-H1N1 cases reported in SwiFT, one patient was reported to have been refused critical care owing to lack of available staff and beds, and the remaining two patients received critical care in an extended critical care area.

Of the suspected and confirmed H1N1 cases reported in SwiFT, one patient was reported to have been refused critical care owing to perceived futility, one patient was reported refused critical care owing to lack of available staff and beds, two patients died while under assessment before transfer to a critical care unit could be arranged, 42 patients received critical care in an extended critical care area, two patients received critical care in a non-critical care area, and 11 patients were transferred to receive critical care in another acute hospital.

Complete data for the period April 2007 to March 2010 were available for 125 adult, general critical care units in the CMPD. There was no clear pattern to indicate either higher absolute numbers of admissions during the pandemic (*Figure 13*) or lower numbers of admissions following elective or scheduled surgery (*Figure 14*). Admissions from recovery only (*Figure 15*), representing use

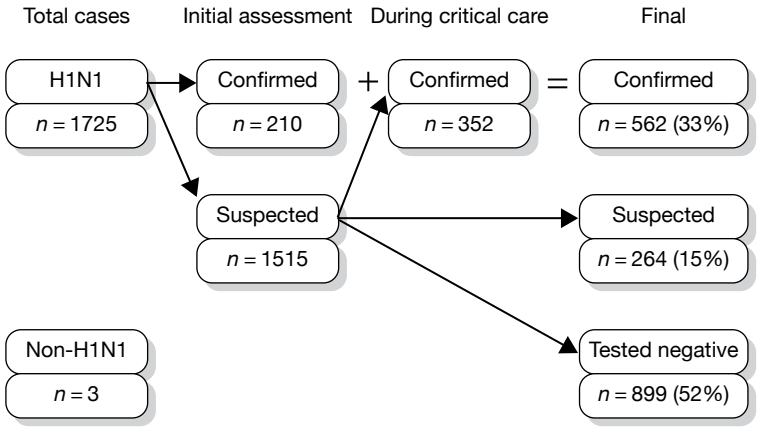

FIGURE 12 *SwiFT case flow.*

of recovery as an extended critical care area, were more frequent in winter, but no more common in 2009–10 than in previous years. Similarly, there was no evidence that transfers between critical care units increased during the pandemic, either overall (*Figure 16*) or for non-clinical reasons (*Figure 17*). It should be noted, however, that none of these figures would identify cases admitted directly to an extended critical care area and managed there without ever being admitted to a critical care unit, as these cases would be outside the scope of the CMP.

Description of cases

Demographics of the cases on initial assessment for critical care are shown in *Table 7*. Confirmed H1N1 cases were younger than those suspected or tested negative, with 92% aged < 65 years. Confirmed cases were more likely to be pregnant (13% of female patients vs 2%–3%) and more likely to be obese/morbidly obese (25% vs 20% for suspected and 13% for tested negative).

Chronic organ dysfunctions, presentation, physiology and acute severity of illness on initial

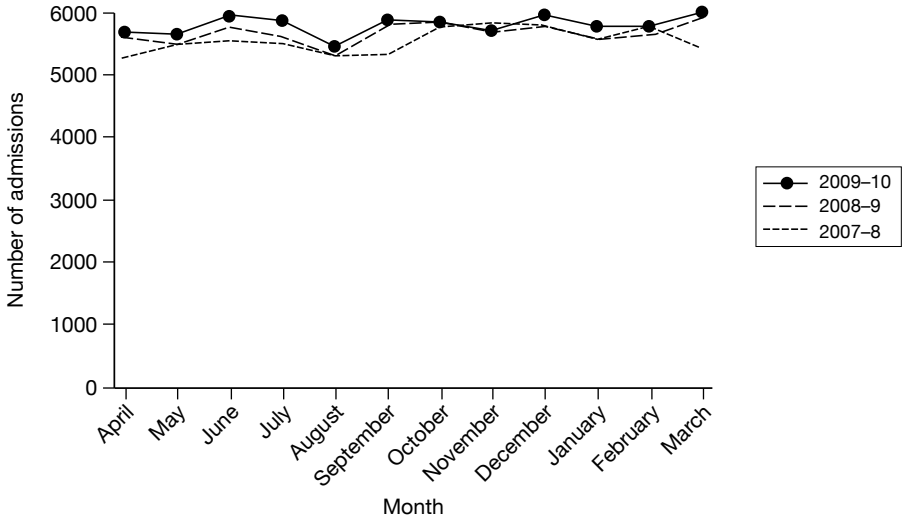

FIGURE 13 *Total number of admissions by month to 125 adult, general critical care units in England, Wales and Northern Ireland with complete data from April 2007 to March 2010.*

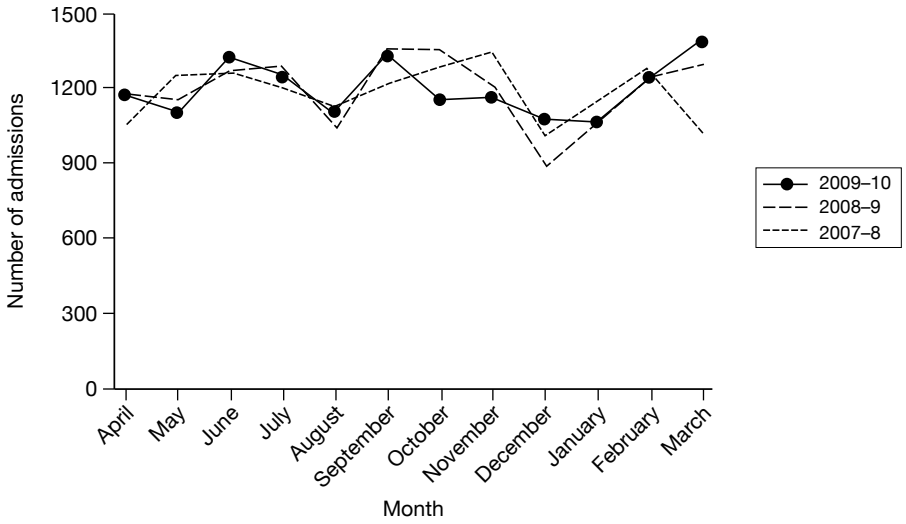

FIGURE 14 *Number of admissions following elective/scheduled surgery by month to 125 adult, general critical care units in England, Wales and Northern Ireland with complete data from April 2007 to March 2010.*

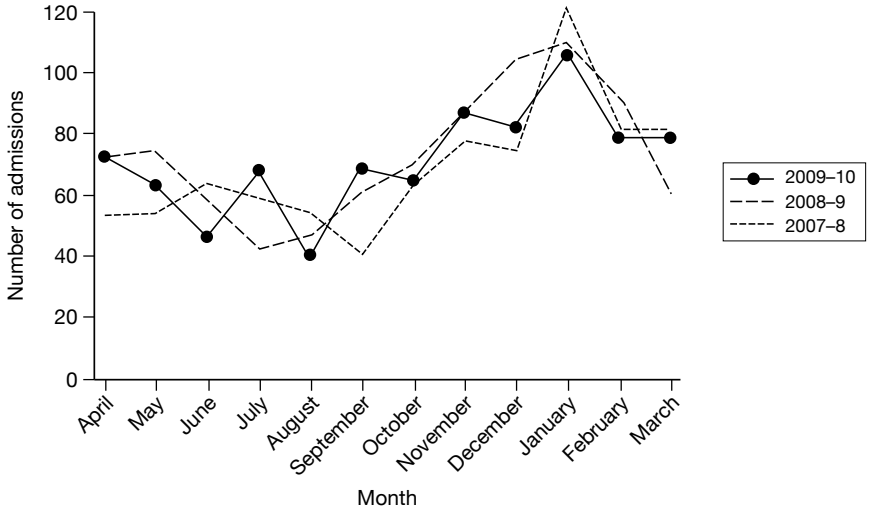

FIGURE 15 *Number of admissions from recovery only (representing use of recovery as an extended critical care area) by month to 125 adult, general critical care units in England, Wales and Northern Ireland with complete data from April 2007 to March 2010.*

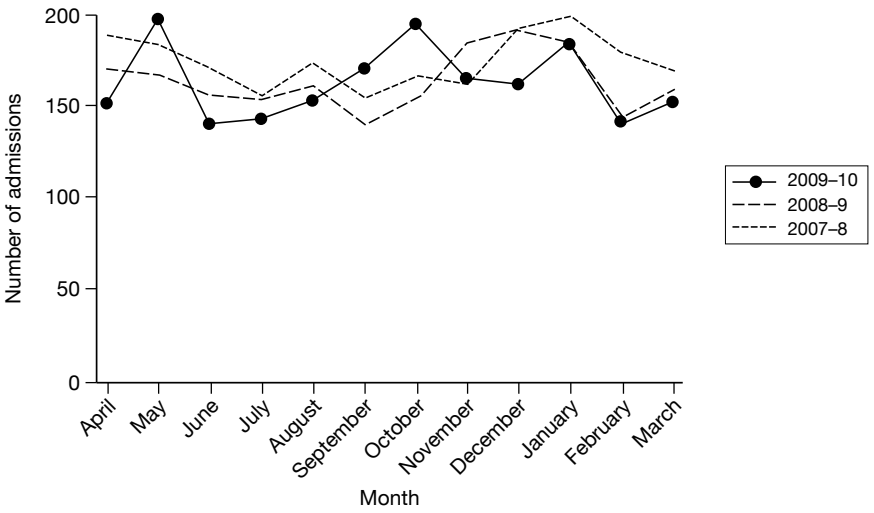

FIGURE 16 *Number of admissions transferred to a critical care unit in another acute hospital by month from 125 adult, general critical care units in England, Wales and Northern Ireland with complete data from April 2007 to March 2010.*

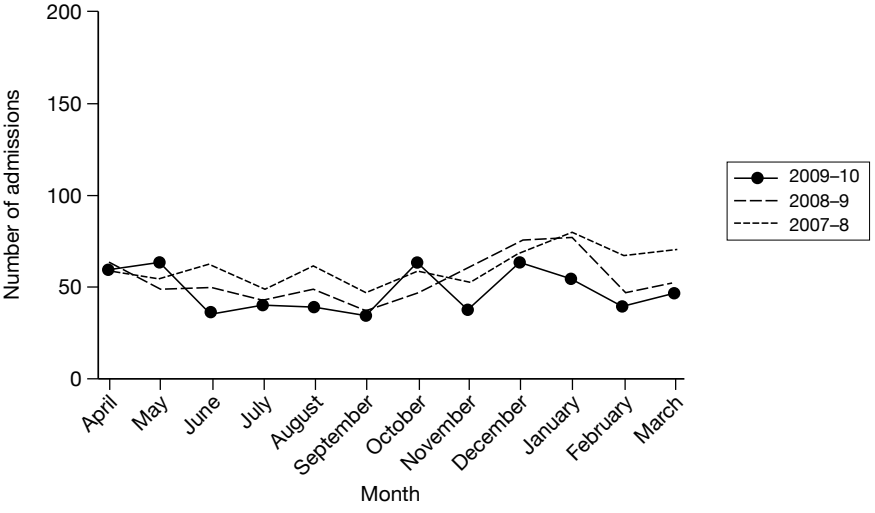

FIGURE 17 *Number of admissions transferred to a critical care unit in another acute hospital for non-clinical reasons by month from 125 adult, general critical care units in England, Wales and Northern Ireland with complete data from April 2007 to March 2010.*

TABLE 7 *Demographics of confirmed, suspected and tested negative H1N1 cases on assessment for critical care*

	Confirmed (*N*=562)	**Suspected (*N*=264)**	**Tested negative (*N*=899)**
Age[a] (years), mean (SD)	40 (18)	46 (23)	46 (25)
Age[a] (years),* n *(%)	**(*N*=558)**	**(*N*=260)**	**(*N*=892)**
< 1	12 (2.2)	4 (1.5)	79 (8.9)
1–4	16 (2.9)	16 (6.2)	38 (4.3)
5–24	84 (15.1)	32 (12.3)	76 (8.5)
25–44	266 (47.7)	87 (33.5)	235 (26.3)
45–64	138 (24.7)	55 (21.2)	221 (24.8)
65+	42 (7.5)	66 (25.4)	243 (27.2)
Ethnicity,* n *(%)			
White	475 (84.5)	215 (81.4)	752 (83.6)
Mixed	4 (0.7)	2 (0.8)	15 (1.7)
Asian or Asian British	46 (8.2)	20 (7.6)	54 (6.0)
Black or black British	15 (2.7)	5 (1.9)	43 (4.8)
Other ethnic group	8 (1.4)	4 (1.5)	5 (0.6)
Not stated	14 (2.5)	18 (6.8)	30 (3.3)
Sex,* n *(%)	**(*N*=560)**	**(*N*=263)**	**(*N*=898)**
Female	292 (52.1)	133 (50.6)	435 (48.4)
Male	268 (47.9)	130 (49.4)	463 (51.6)
Pregnancy status,* n *(% of females)	**(*N*=292)**	**(*N*=133)**	**(*N*=435)**
Currently pregnant	37 (12.7)	4 (3.0)	10 (2.3)
Recently pregnant	14 (4.8)	4 (3.0)	13 (3.0)
Not known to be pregnant	241 (82.5)	125 (94.0)	412 (94.7)
Body composition,* n *(%)	**(*N*=511)**	**(*N*=204)**	**(*N*=775)**
Very thin (BMI < 16 kg m^{-2})	10 (2.0)	4 (2.0)	10 (1.3)
Thin (BMI 16–18.5 kg m^{-2})	30 (5.9)	25 (12.3)	61 (7.9)
Acceptable weight (BMI 18.6–24.9 kg m^{-2})	232 (45.4)	94 (46.1)	424 (54.7)
Overweight (BMI 25–29.9 kg m^{-2})	109 (21.3)	40 (19.6)	173 (22.3)
Obese (BMI 30–39.9 kg m^{-2})	93 (18.2)	25 (12.3)	81 (10.5)
Morbidly obese (BMI ≥ 40 kg m^{-2})	37 (7.2)	16 (7.8)	26 (3.4)

SD, standard deviation.
a Note that age statistics may not be representative owing to under-representation of paediatric patients assessed in hospitals with no paediatric critical care services.

assessment for critical care are reported in *Table 8*. Overall, one-third of confirmed H1N1 cases had one or more severe chronic organ dysfunctions (including being immunocompromised). This was similar for those suspected or tested negative. Unsurprisingly, the most common severe chronic organ dysfunction was of the respiratory system (26% of confirmed H1N1 cases). Vital signs and oxygenation data were available for between 84% (temperature) and 92% (heart rate) of cases. Further test results were available for between 26% (creatine kinase) and 73% (base excess) of cases. Acute severity of illness on initial referral and assessment for critical care, as assessed by the CURB-65 score, was low with 61% of confirmed H1N1 cases scoring 0 or 1 point.

TABLE 8 *Chronic organ dysfunctions, presentation, physiology and acute severity for confirmed, suspected and tested negative H1N1 cases on assessment for critical care*

	Confirmed (*N*=562)	**Suspected (*N*=264)**	**Tested negative (*N*=899)**
Respiratory organ dysfunction,* n *(%)			
Moderate	112 (19.9)	50 (18.9)	199 (22.1)
Severe	145 (25.8)	51 (19.3)	238 (26.5)
Cardiovascular organ dysfunction,* n *(%)			
Moderate	63 (11.2)	30 (11.4)	110 (12.2)
Severe	25 (4.4)	20 (7.6)	50 (5.6)
Renal organ dysfunction,* n *(%)			
Moderate	27 (4.8)	13 (4.9)	44 (4.9)
Severe	17 (3.0)	11 (4.2)	22 (2.4)
Hepatic organ dysfunction,* n *(%)			
Moderate	16 (2.8)	7 (2.7)	33 (3.7)
Severe	7 (1.2)	2 (0.8)	4 (0.4)
Neurological organ dysfunction,* n *(%)			
Moderate	31 (5.5)	16 (6.1)	38 (4.2)
Severe	29 (5.2)	8 (3.0)	45 (5.0)
Immunocompromised,* n *(%)	***40 (7.1)***	***15 (5.7)***	***66 (7.3)***
Any chronic organ dysfunction,* n *(%)			
None	223 (39.7)	127 (48.1)	337 (37.5)
Moderate	138 (24.6)	57 (21.6)	228 (25.4)
Severe or immunocompromised	201 (35.8)	80 (30.3)	334 (37.2)
Reported presentation,* n *(%)	**(*N*=537)**	**(*N*=229)**	**(*N*=857)**
Viral pneumonitis/ARDS	224 (41.7)	47 (20.5)	199 (23.2)
Secondary bacterial pneumonia	164 (30.5)	72 (31.4)	312 (36.4)
Exacerbation of airflow limitation	95 (17.7)	53 (23.1)	180 (21.0)
Intercurrent illness with H1N1	54 (10.1)	57 (24.9)	166 (19.4)
Physiology on initial assessment			
Temperature (°C), mean (SD) [*n*]	37.6 (2.0) [500]	37.1 (1.5) [203]	37.0 (1.4) [743]
Systolic blood pressure (mmHg), mean (SD) [*n*]	122 (28) [527]	118 (30) [219]	118 (30) [818]
Heart rate (minute^{-1}), mean (SD) [*n*]	111 (24) [529]	115 (29) [225]	115 (29) [837]
Respiratory rate (minute^{-1}), mean (SD) [*n*]	29 (10) [497]	29 (11) [218]	31 (13) [781]
O_2 saturation (%), mean (SD) [*n*]	91.4 (7.5) [517]	92.0 (8.6) [226]	93.3 (6.7) [817]
FiO_2 (%), mean (SD) [*n*]	69 (26) [501]	60 (29) [213]	66 (27) [787]
Base excess (mEq l^{-1}), median (IQR) [*n*]	–1.3 (–4.6 to 2.0) [408]	–2.7 (–6.3 to 1.5) [184]	–2.4 (–6.4 to 1.5) [660]
Blood lactate (mmol l^{-1}), median (IQR) [*n*]	1.2 (0.9 to 2.2) [327]	2.0 (1.1 to 4.1) [139]	1.7 (1.1 to 3.2) [526]
Serum urea (mmol l^{-1}), median (IQR) [*n*]	5.5 (3.3 to 8.9) [403]	7.0 (4.1 to 12.2) [166]	6.9 (4.2 to 11.6) [612]
Creatine kinase (U l^{-1}), median (IQR) [*n*]	92 (65 to 231) [175]	108 (62 to 206) [60]	100 (66 to 170) [219]
CURB-65, mean (SD)	1.3 (1.0)	1.4 (1.2)	1.7 (1.1)

TABLE 8 *Chronic organ dysfunctions, presentation, physiology and acute severity for confirmed, suspected and tested negative H1N1 cases on assessment for critical care (continued)*

	Confirmed (*N* = 562)	**Suspected (*N* = 264)**	**Tested negative (*N* = 899)**
CURB-65*, n *(%)			
0	117 (20.8)	65 (24.6)	117 (13.0)
1	226 (40.2)	91 (34.5)	300 (33.4)
2	153 (27.2)	54 (20.5)	263 (29.3)
3	55 (9.8)	37 (14.0)	167 (18.6)
4	9 (1.6)	16 (6.1)	48 (5.3)
5	2 (0.4)	1 (0.4)	4 (0.4)
SOFA score, mean (SD)	***5.7 (4.0)***	***5.2 (4.2)***	***5.6 (3.7)***
SOFA score*, n *(%)	**(*N* = 547)**	**(*N* = 225)**	**(*N* = 899)**
0–2	130 (23.8)	73 (32.4)	216 (24.0)
3–6	205 (37.5)	76 (33.8)	330 (36.7)
7–10	127 (23.2)	42 (18.7)	258 (28.7)
11+	85 (15.5)	34 (15.1)	95 (10.6)

SD, standard deviation.

The duration of critical care is presented in *Figure 18*, with patients whose last known status was receiving critical care ($n = 18$) treated as being censored at this date. The median duration of critical care was 8.5 days for confirmed H1N1, 1.3 days for suspected H1N1 and 5.4 days for those patients tested negative. The mean duration of critical care was 13.5 days, 2.1 days and 10.4 days, respectively. Of those receiving critical care in the original hospital, data on survival status were available for 537 of 556 (97%) confirmed H1N1, 223 of 255 (87%) suspected H1N1 and 891 of 899 (99%) of those tested negative. Of those with complete data, 423 of 537 (79%), 154 of 223 (69%) and 754 of 891 (85%), respectively, survived to the end of critical care.

Performance of triage models

Of 1651 patients with confirmed or suspected H1N1 on initial assessment: 320 (19.4%) died while receiving critical care; 850 (51.5%) survived to the end of critical care and were reported to have received advanced respiratory support, advanced cardiovascular support, renal support, hepatic support and/or neurological support; and 481 (29.1%) survived to the end of critical care and were not reported to have received support for any of these organ systems. The concordance (95% CI) of the simple physiology-based triage score and CURB-65 for discriminating among these groups was 0.613 (95% CI 0.590 to 0.637) and 0.615 (95% CI 0.595 to 0.634), respectively.

Risk factors for death and duration of critical care

The results of the Cox proportional hazards regression model for death while receiving critical care are displayed in *Table 9* and *Figure 19*. A hazard ratio > 1 represents a higher risk of death and a hazard ratio < 1 represents a lower risk of death. Increasing risk of death was associated with increasing age > 30 years, increasing SOFA score, severe chronic organ dysfunction and being immunocompromised. Pregnancy was associated with a lower risk of death.

The results of the Cox proportional hazards regression model for duration of critical care among survivors are displayed in *Table 10* and *Figure 20*. A hazard ratio < 1 represents a longer duration of critical care and a hazard ratio > 1 represents a shorter duration of critical care. Increasing duration of critical care was associated with increasing age up to 50 years (with a possible decrease at the oldest ages), increasing SOFA score, overweight or obesity, pregnancy, confirmed H1N1 on initial assessment, severe chronic organ dysfunction, and presentation with viral pneumonitis/ARDS or secondary bacterial pneumonia.

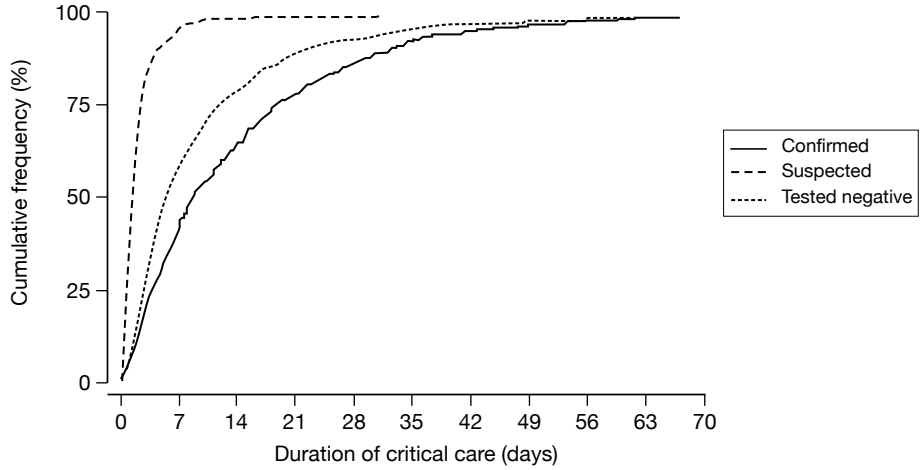

FIGURE 18 *Duration of critical care for confirmed, suspected and tested negative H1N1 cases.*

TABLE 9 *Hazard ratios for death while receiving critical care*

Risk factor	Deaths/*N* (%)	Hazard ratio (95% CI)	*p*-value
Age (years)		See *Figure 19*	<0.001
Sex			***0.46***
Female	143/835 (17.1)	1.00	
Male	177/827 (21.4)	1.09 (0.87 to 1.37)	
Ethnicity			***0.75***
White	279/1402 (19.9)	1.00	
Non-white	41/260 (15.8)	0.94 (0.67 to 1.33)	
Body composition			***0.99***
Very thin/thin/acceptable weight	196/1074 (18.2)	1.00	
Overweight	70/317 (22.1)	0.99 (0.75 to 1.31)	
Obese/morbidly obese	54/271 (19.9)	0.98 (0.71 to 1.34)	
Pregnancy status			***0.048***
Not known to be pregnant	318/1581 (20.1)	1.00	
Currently or recently pregnant	2/81 (2.5)	0.13 (0.19 to 0.98)	
H1N1 status on initial assessment			***1.00***
Suspected	280/1467 (19.1)	1.00	
Confirmed	40/195 (20.5)	1.00 (0.70 to 1.43)	
Reported presentation			***0.31***
Viral pneumonitis/ARDS	88/459 (19.2)	1.00	
Secondary bacterial pneumonia	113/541 (20.9)	0.91 (0.68 to 1.22)	
Exacerbation of airflow limitation	52/320 (16.3)	0.82 (0.57 to 1.19)	
Intercurrent illness	53/267 (19.9)	1.16 (0.83 to 1.61)	
Location of assessment			***0.32***
Non-ED	234/1174 (19.9)	1.00	
ED	86/488 (17.6)	0.88 (0.68 to 1.13)	

TABLE 9 *Hazard ratios for death while receiving critical care (continued)*

Risk factor	Deaths/*N* (%)	Hazard ratio (95% CI)	*p*-value
Chronic organ dysfunction			***0.008***
None/mild	94/710 (13.2)	1.00	
Moderate	89/439 (20.3)	1.18 (0.87 to 1.60)	
Severe	137/513 (26.7)	1.53 (1.16 to 2.02)	
Immunocompromised			***0.005***
No	282/1542 (18.3)	1.00	
Yes	38/120 (31.7)	1.65 (1.16 to 2.33)	
SOFA score (per point)		***1.05 (1.02 to 1.08)***	***0.001***

ED, emergency department.

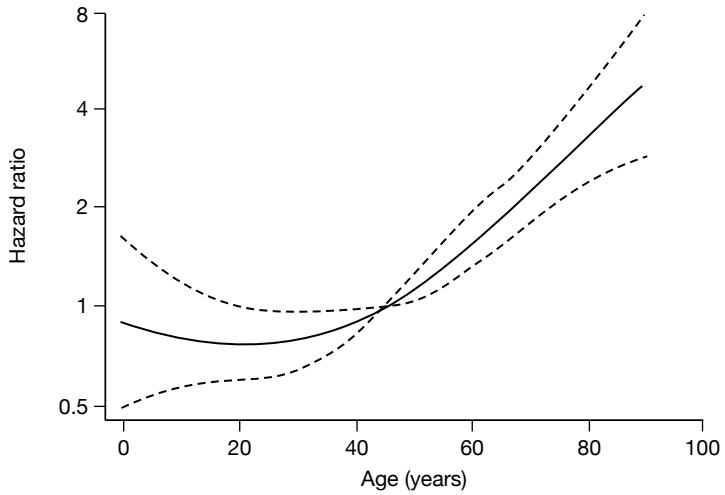

FIGURE 19 *Hazard ratio and 95% CI for death while receiving critical care by age relative to age 45 years.*

TABLE 10 *Hazard ratios for duration of critical care among survivors*

Risk factor	*N*	Hazard ratio (95% CI)	*p*-value
Age (years)		See *Figure 20*	<0.001
Sex			***0.61***
Female	692	1.00	
Male	650	1.03 (0.92 to 1.15)	
Ethnicity			***0.76***
White	1123	1.00	
Non-white	219	0.98 (0.84 to 1.14)	
Body composition			***0.032***
Very thin/thin/acceptable weight	878	1.00	
Overweight	247	0.85 (0.73 to 0.99)	
Obese/morbidly obese	217	0.85 (0.72 to 1.00)	

continued

TABLE 10 *Hazard ratios for duration of critical care among survivors (continued)*

Risk factor	*N*	Hazard ratio (95% CI)	*p*-value
Pregnancy status			***0.004***
Not known to be pregnant	1263	1.00	
Currently or recently pregnant	79	0.76 (0.58 to 0.98)	
H1N1 status on initial assessment			***0.004***
Suspected	1187	1.00	
Confirmed	155	0.77 (0.65 to 0.92)	
Reported presentation			***<0.001***
Viral pneumonitis/ARDS	371	1.00	
Secondary bacterial pneumonia	428	1.03 (0.89 to 1.19)	
Exacerbation of airflow limitation	268	1.38 (1.16 to 1.64)	
Intercurrent illness	214	1.22 (1.03 to 1.43)	
Location of assessment			***0.45***
Non-ED	940	1.00	
ED	402	1.05 (0.93 to 1.18)	
Chronic organ dysfunction			***<0.001***
None/mild	616	1.00	
Moderate	350	0.94 (0.82 to 1.09)	
Severe	376	0.76 (0.66 to 0.87)	
Immunocompromised			***0.15***
No	1,260	1.00	
Yes	82	1.18 (0.94 to 1.49)	
SOFA score (per point)		***0.93 (0.91 to 0.94)***	***<0.001***

ED, emergency department.

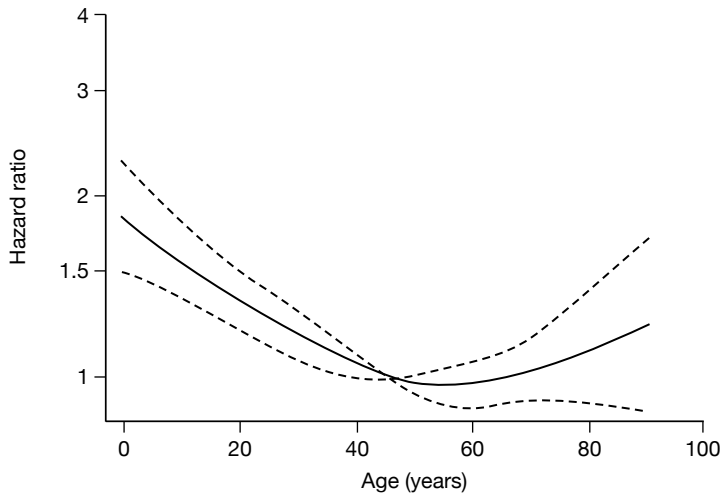

FIGURE 20 *Hazard ratio and 95% CI for duration of critical care among survivors by age relative to age 45 years.*

Discussion

SwiFT successfully collected data on > 1700 critically ill patients who were affected by the H1N1 pandemic, either directly (as a confirmed or suspected H1N1 case) or indirectly through not being admitted to a critical care unit as a result of the pandemic ($n = 3$). However, two time lags influenced the capture and reporting for SwiFT. The first was the time lag for hospitals to start collecting data and the second was the time lag for entering data onto the web portal (16% of eligible patients and 19% of data for daily assessments were added retrospectively, i.e. after the end of the pandemic).

Return of the final declaration forms identified a potential under-reporting of cases. Around one-third of participating hospitals indicated that they reported only cases admitted to their adult, general critical care unit, and it is probable that this problem was more widespread. As paediatric critical care in the UK is regionalised, many children requiring critical care may well have been assessed in the emergency department and directly transferred/retrieved to a paediatric intensive care unit in another hospital – this assessment and possible subsequent admission to a paediatric intensive care unit being missed from the SwiFT database.

Many regarded SwiFT as an adult, general critical care unit based study, rather than a whole hospital study. However, this misunderstanding of the scope did not lead to SwiFT missing adult cases as all got admitted to a critical care location (but would have done so had the pandemic overwhelmed the available critical care resources). Consequently, coverage of the database was evaluated only for hospitals admitting adult patients, which was estimated to be 39% (46% in England) for the time period from central R&D approval to the close of recruitment.

Hospital participation in SwiFT varied greatly across the five countries. Owing to the relatively small number of cases from outside England, international comparisons within SwiFT were not considered to be meaningful. The large proportion of cases from sites in England tended to overwhelm those from other countries, and the results therefore may not be generalisable outside of England.

The magnitude and severity of the H1N1 pandemic in the UK was not as extreme as had been feared, and certainly did not approach the 'reasonable worst-case scenario' figures used for preparedness planning, which predicted a demand for critical care beds of up to 10 times capacity.[17] The substantial discordance, between the 'reasonable worst-case scenario' and that experienced, underlines the caution that needs to be exercised in accepting modelled data for any new pathogen or for a known pathogen in a new context. To this end, the existing critical care capacity coped with only a minority of patients experiencing a level of critical care provision lower than in normal, non-pandemic circumstances. One patient (with suspected or confirmed H1N1) assessed as requiring critical care was reported to have not been admitted on grounds of perceived futility, and two patients (one H1N1, one non-H1N1) were reported to have not received critical care owing to the lack of an available staffed bed. These reported cases were not followed up in detail.

Caution should also be applied in using SwiFT data to model future outbreaks. While SwiFT data would provide reasonably robust estimates for modelling critical care requirements in a subsequent outbreak of an unchanged virus in the UK, it is important to recognise several caveats. First, changes in population immunity (either natural or due to immunisation) may modify disease load, both across the UK and within local communities. Second, these estimates could suffer from substantial inaccuracy if there is a significant change in the antigenicity of the virus. Third, the estimates could be erroneous if applied to a new virus [e.g. H5N1 (avian influenza)]. These considerations make a strong case for even earlier accumulation of data than that achieved by SwiFT in the course of any future epidemic.

The age distribution of confirmed H1N1 cases is consistent with a serological survey of pre-pandemic samples, which indicated increasing antibody titres with age.[33] Overall, 23% of adults aged ≥65 years were protected against H1N1 (haemagglutination inhibition titre ≥1:32), attributed to exposure to influenza H1 strains circulating in the first half of the twentieth century. The increased susceptibility of pregnant women to complications associated with influenza has previously been noted in this pandemic,[34] previous pandemics[35,36] and seasonal influenza.[37]

Although the H1N1 cases had long durations of critical care and of respiratory support (median 8.5 days), their severity of illness on initial

presentation (as assessed by the CURB-65 score) was remarkably low, with 61% of confirmed H1N1 cases referred and assessed as requiring critical care scoring 0 or 1 point. According to Department of Health guidelines drawn up by the British Thoracic Society, British Infection Society and HPA (well in advance of the current pandemic),[14] such patients would be triaged for management at home and not even be admitted to hospital. These low scores may be due, in part, to missing data. Of 562 confirmed H1N1 cases, 162 (29%) were missing creatinine, 159 (28%) were missing urea, 65 (12%) were missing respiratory rate, 35 (6%) were missing blood pressure and 4 (1%) were missing age. However, even when restricted to the 277 (49%) confirmed H1N1 cases with complete data for all five components, 150 (54%) scored 0 or 1 point. It has previously been noted that CURB-65 may under-represent severity in young adults with certain atypical pneumonias.[38] A complementary NIHR-funded study evaluating triage for hospital admission during the H1N1 pandemic also noted low CURB-65 scores.[29] Of 134 adult patients assessed in the emergency department, 101 (75%) had a CURB-65 score of 0, and 24 (18%) had a score of 1, with only nine patients (7%) having a score of ≥2. Of those with a score of 0, 25% were admitted to hospital, and 46% of those with a score of 1. Only five patients experienced 'poor outcomes' (death or requirement for respiratory support), and four of these five patients had a CURB-65 score of 0 or 1.

Of confirmed H1N1 patients receiving critical care, 79% survived to the end of critical care within the original hospital. The SwiFT protocol proposed longer-term follow-up using linkage to national death registration. Unfortunately, such linkage is not currently available without recording patients' full names. The inclusion of these identifiable data was regarded as potentially increasing the complexity (particularly relating to ethics approval) and, hence, associated timelines, for central and local approvals for SwiFT. Algorithms for linkage to the NHS Central Register, using NHS Number without the need for patient names, are currently being developed by the NHS Information Centre. In response to a request to link data, the Medical Research Customer Account Manager responded that, 'Using NHS number only would be a move away from our established practice and is considered a high risk strategy. Our current system can't automatically match on NHS number alone, the only way this could be achieved would be for an operator to key in the NHS number, but without any data fields to match on there is a risk of wrong association. Plus the volume of numbers you wish to match would mean significant man hours and cost to do this. We are developing a new system which we hope will be in use by the end of 2010, this will be more flexible for automatic matching'. It may therefore be possible to follow up the longer-term outcomes of SwiFT patients at a later date.

The discrimination of the simple, physiology-based triage model and CURB-65 in the SwiFT cohort was very similar, and worse than in the development data set. However, the discrimination should be considered in the context that these models were developed in non-H1N1 cohorts and that all presenting patients should be triaged during a pandemic and not just those afflicted. In addition, the performance of the simple, physiology-based triage model may have been affected by differences in data collection time period (first 24 hours in the critical care unit vs at assessment for critical care) and outcome (hospital discharge vs end of critical care) between the development data and SwiFT. In light of this, and the pandemic not overwhelming critical care services, further development of the simple, physiology-based triage score, using emerging data from SwiFT, was not attempted.

The risk factors for death while receiving critical care identified for H1N1 cases in SwiFT predominantly reflected common, established risk factors for death in critical care (age, chronic organ dysfunction and acute organ failure). The finding that pregnancy was associated with a lower risk of death may reflect a lower threshold for admission to critical care among pregnant patients. It has also been noted previously that severity of illness scores overpredict mortality among pregnant patients.[39] This may be due to apparent physiological derangements that are due to pregnancy and not associated with the acute illness and therefore not predictive of outcome.

Chapter 4

Comparison of confirmed H1N1 cases from SwiFT with pre-pandemic, wave 1 and international cohorts

Introduction

A number of other H1N1 registries were established internationally.[2] This chapter presents a comparison of the findings from SwiFT in the context of the available, published results from these other international endeavours. These comparisons include identification of H1N1 cases from wave 1 of the pandemic in the UK, and comparison with pre-pandemic cohorts, using data from the CMP.

Methods

Identification of comparator data – UK wave 1 H1N1 pandemic and pre-pandemic cohorts

Data for critically ill, UK patients, from the first wave of the H1N1 pandemic and for pre-pandemic comparator cohorts, were identified from the CMP (see *Chapter 2* for a description of data collection and validation).

Early in the pandemic, all critical care units participating in the CMP were contacted with a request to submit individual data files for patients with confirmed or suspected H1N1 rather than waiting to submit these cases in their routine quarterly data submission for the CMP. Cases were identified in the free text field of the data set with the words 'Confirmed Swine Flu Case' or 'Suspected Swine Flu Case'. The free text of all routinely submitted data was also searched for relevant terms (e.g. 'H1N1', 'pandemic influenza') to identify any additional cases that were not reported in this way. For the purpose of this comparison, the wave 1 H1N1 cohort has been defined to be all confirmed H1N1 cases, identified in this way, that were admitted to critical care units participating in the CMP between 1 June 2009 and 31 August 2009.

Pre-pandemic cohorts were selected using data from 1 December 2007 to 31 March 2008 and 1 December 2008 to 31 March 2009 to represent the previous two influenza seasons. Two, pre-pandemic cohorts were identified based on the primary, secondary and ultimate primary reason for admission to the critical care unit, coded using the ICNARC Coding Method.[20] The primary (mandatory) and secondary (optional) reasons for admission are coded based on information available up to and including the first 24 hours in the critical care unit. The primary reason for admission may be updated to an ultimate primary reason for admission based on information that became available later. The two cohorts were defined as follows:

- *Viral pneumonia*: admissions with 'Viral pneumonia' coded as the primary, secondary or ultimate primary reason for admission.
- *Bacterial pneumonia*: admissions with 'Bacterial pneumonia' or 'Pneumonia, no organism isolated' coded as the primary, secondary or ultimate primary reason for admission and without 'Viral pneumonia' in any of these fields.

Identification of comparator data – international cohorts

International comparator data were extracted from published cohorts of critically ill patients with H1N1. Four appropriate cohorts were identified:

- Seven hundred and twenty-two patients from wave 1 of the pandemic in Australia and New Zealand (June–August 2009) admitted to an adult or paediatric intensive care unit with confirmed H1N1 according to WHO definitions (see *Appendix 4*).[3]
- One hundred and sixty-eight patients from wave 1 of the pandemic in Canada (April–August 2009) identified as critically ill (defined as admitted to an adult or paediatric intensive

care unit, or mechanically ventilated, or FiO_2 ≥60%, or receiving intravenous inotrope or vasopressor) with confirmed or probable H1N1 according to WHO definitions.[40]
- Fifty-eight patients from wave 1 of the pandemic in Mexico (March–June 2009) identified as critically ill (defined as for Canada) with confirmed, probable or suspected H1N1 according to WHO definitions.[41]
- Thirty-two patients from wave 1 of the pandemic in Spain (June–July 2009) admitted to an adult intensive care unit (age ≥15 years) with confirmed H1N1 according to WHO definitions.[42]

Descriptive analysis

Confirmed H1N1 cases from SwiFT were compared with the wave 1 H1N1 pandemic and pre-pandemic cohorts based on information that was available and similarly defined in SwiFT, and in at least one comparator data set.

Results

Data were extracted from the CMPD for 116 reported, confirmed H1N1 cases from wave 1 of the pandemic (June–August 2009) and for pre-pandemic cohorts of 74 admissions with viral pneumonia and 7279 admissions with bacterial pneumonia (December–March, 2008 and 2009). The demographics of these admissions compared with the confirmed H1N1 cases from SwiFT are shown in *Table 11*. H1N1 pandemic wave 1 (CMP) and wave 2 (SwiFT) were very similar in terms of age and sex distribution and the proportion of pregnant patients; however, the cases reported

TABLE 11 *Demographics of confirmed H1N1 cases from SwiFT compared with UK wave 1 and pre-pandemic cohorts*

	SwiFT	**CMP**		
	Pandemic wave 2 (*N*=562)	**Pandemic wave 1 (*N*=116)**	**Pre-pandemic (viral pneumonia) (*N*=74)**	**Pre-pandemic (bacterial pneumonia) (*N*=7279)**
	(*N*=558)	**(*N*=114)**	**(*N*=74)**	**(*N*=7279)**
Age[a] (years)				
Mean (SD)	40 (18)	40 (16)	52 (19)	62 (17)
Median (IQR)	40 (27 to 53)	41 (28 to 52)	53 (36 to 67)	66 (53 to 75)
<65, *n* (%)	516 (92.5)	103 (90.4)	54 (73.0)	3470 (47.7)
Ethnicity,* n *(%)				
White	475 (84.5)	60 (51.7)	61 (82.4)	6555 (90.1)
Mixed	4 (0.7)	3 (2.6)	0 (0.0)	32 (0.4)
Asian or Asian British	46 (8.2)	28 (24.1)	7 (9.5)	218 (3.0)
Black or black British	15 (2.7)	14 (12.1)	3 (4.1)	108 (1.5)
Other ethnic group	8 (1.4)	5 (4.3)	2 (2.7)	45 (0.6)
Not stated	14 (2.5)	6 (5.2)	1 (1.4)	321 (4.4)
Sex,* n *(%)	**(*N*=560)**	**(*N*=116)**	**(*N*=74)**	**(*N*=7279)**
Female	292 (52.1)	59 (50.9)	31 (41.9)	3163 (43.5)
Male	268 (47.9)	57 (49.1)	43 (58.1)	4116 (56.5)
Pregnancy status,* n *(% of females)	**(*N*=292)**	**(*N*=59)**	**(*N*=31)**	**(*N*=3163)**
Currently pregnant	37 (12.7)	9 (15.3)	1 (3.2)	28 (0.9)
Recently pregnant	14 (4.8)	7 (11.9)	0 (0.0)	29 (0.9)
Not known to be pregnant	241 (82.5)	43 (72.9)	30 (96.8)	3106 (98.2)

SD, standard deviation.
a SwiFT includes paediatric patients, but these cases are under-represented; the CMP includes admissions to adult critical care units only.

from wave 1 had a markedly different ethnic distribution with higher proportions of patients of Asian or black ethnicity. Patients from both pandemic waves were, on average, 12 years younger than pre-pandemic patients with viral pneumonia and 22 years younger than pre-pandemic patients with bacterial pneumonia. In the pre-pandemic cohorts, there was a slight majority of male patients, whereas in the pandemic cohorts the sexes were equally distributed. The proportion of pregnant patients was much lower in the pre-pandemic cohorts.

Table 12 summarises the organ support received at any time during critical care. The proportion of patients receiving advanced respiratory support was slightly higher in the pandemic cohorts and, among those receiving advanced respiratory support, the median duration of support was longer than for pre-pandemic bacterial pneumonia and slightly shorter than for pre-pandemic viral pneumonia. The proportion of patients receiving advanced cardiovascular support was similar for all cohorts. The proportion of patients receiving renal support was slightly higher, and the duration of support longer, for the pandemic cohorts than for pre-pandemic bacterial pneumonia, but similar to that for pre-pandemic viral pneumonia. The proportion of patients receiving hepatic support was very low in all cohorts. The proportion of patients receiving neurological support was particularly low in SwiFT compared with all other cohorts.

Table 13 shows the outcome and duration of critical care (calculated from the date and time critical care commenced to the date and time critical care ended). Critical care mortality was lower in SwiFT than in wave 1 and pre-pandemic viral pneumonia, which were lower in turn than pre-pandemic bacterial pneumonia. The duration of critical care was longer in the pandemic cohorts than the pre-pandemic cohorts, particularly among non-survivors.

Table 14 shows the demographics of the confirmed H1N1 cases in SwiFT compared with the four, published international cohorts.[3,40–42] All patients reported for SwiFT, Australia and New Zealand, and Spain had confirmed H1N1, by definition. Although the Canadian report included cases with probable H1N1, these accounted for only 4% of the cohort.[40] By contrast, in the Mexican cohort, only 50% of patients were reported to have confirmed H1N1, with 24% probable and 26% suspected.[41] The age distribution was broadly similar in all countries, with all reporting a very high proportion of cases being aged < 65 years. The sex distribution of cases varied across countries, ranging from only one-quarter of cases being female in Spain to

TABLE 12 *Organ support for confirmed H1N1 cases from SwiFT compared with UK wave 1 and pre-pandemic cohorts*

	SwiFT	**CMP**		
	Pandemic wave 2 (*N* = 547)	**Pandemic wave 1 (*N* = 115)**	**Pre-pandemic (viral pneumonia) (*N* = 72)**	**Pre-pandemic (bacterial pneumonia) (*N* = 7204)**
Advanced respiratory support				
n (%)	421 (77.0)	82 (71.3)	48 (66.7)	4795 (66.6)
Median duration (days)	9	9	11	6
Advanced cardiovascular support				
n (%)	197 (36.0)	43 (37.4)	30 (41.7)	2770 (38.5)
Median duration (days)	4	3	3	2
Renal support				
n (%)	112 (20.5)	27 (23.5)	15 (20.8)	1068 (14.8)
Median duration (days)	6	5	6	4
Hepatic support,* n *(%)	***6 (1.1)***	***1 (0.9)***	***0 (0.0)***	***9 (0.1)***
Neurological support,* n *(%)	***16 (2.9)***	***11 (9.6)***	***12 (16.7)***	***811 (11.3)***

TABLE 13 *Outcome and duration of critical care for confirmed H1N1 cases from SwiFT compared with UK wave 1 and pre-pandemic cohorts*

	SwiFT	CMP		
	Pandemic wave 2 (*N* = 537)	Pandemic wave 1 (*N* = 116)	Pre-pandemic (viral pneumonia) (*N* = 74)	Pre-pandemic (bacterial pneumonia) (*N* = 7279)
Deaths during critical care,* n *(%)	***114 (21.2)***	***31 (26.7)***	***19 (25.7)***	***2227 (30.6)***
Duration of critical care (days), median (IQR)				
All	8.5 (3.7 to 18.6)	6.9 (2.6 to 14.6)	6.6 (2.1 to 18.0)	4.9 (1.9 to 11.0)
Survivors	8.6 (3.9 to 18.8)	6.7 (2.5 to 14.6)	8.0 (2.1 to 19.2)	5.5 (2.6 to 12.1)
Non-survivors	7.6 (3.1 to 14.6)	7.2 (3.1 to 14.8)	4.9 (1.8 to 13.5)	3.1 (0.9 to 8.9)

TABLE 14 *Demographics of confirmed H1N1 cases from SwiFT compared with international wave 1 H1N1 pandemic cohorts*

	SwiFT (*N* = 562)	Australia and New Zealand (*N* = 722)	Canada (*N* = 168)	Mexico (*N* = 58)	Spain (*N* = 32)
Confirmed H1N1,* n *(%)	***562 (100)***	***722 (100)***	***162 (96.4)***	***29 (50.0)***	***32 (100)***
Age[a] (years)	**(*N* = 558)**	**(*N* = 722)**	**(*N* = 168)**	**(*N* = 58)**	**(*N* = 32)**
Mean (SD)	40 (18)	–	32 (21)	–	40 (14)
Median (IQR)	40 (27 to 53)	40 (26 to 54)	–	44	36 (31 to 52)
<65 years, *n* (%)	516 (92.5)	669 (92.7)	158 (94.0)	(84–90[b])	31 (96.9)
Sex,* n *(%)	**(*N* = 560)**	**(*N* = 722)**	**(*N* = 168)**	**(*N* = 58)**	**(*N* = 32)**
Female	292 (52.1)	376 (52.1)	113 (67.3)	31 (53.4)	11 (26.7)
Male	268 (47.9)	346 (47.9)	55 (32.7)	27 (46.6)	21 (73.3)
Currently pregnant, *n* (% of female)	37 (12.7)	66 (17.6)	13 (11.5)	1 (3.2)	2 (18.2)
Obesity,* n *(%)	**(*N* = 511)**	**(*N* = 601)**	**(*N* = 168)**	**(*N* = 58)**	**(*N* = 32)**
BMI ≥ 30	130 (25.4)	–	56 (33.3)	21 (36.2)	10 (31.3)
BMI ≥ 35	–	172 (28.6)	–	–	–
BMI ≥ 40	37 (7.2)	–	28 (16.7)	8 (13.8)	4 (12.5)

SD, standard deviation.
a SwiFT includes paediatric patients, but these cases are under-represented; Australia and New Zealand, Canada and Mexico are reported to include all adult and paediatric cases; and Spain includes cases admitted to adult critical care units only.
b Estimated from figure presented in 10-year age bands.

approximately two-thirds of cases in Canada. All countries except Mexico reported high proportions of pregnant cases. The prevalence of obesity among H1N1 cases was higher in other countries than in the SwiFT data, with around one-third of cases being obese (compared with around one-quarter in SwiFT, which is similar to the national average).

Case presentation was reported in a comparable manner in the reports from Australia and New Zealand and from Spain (*Table 15*). The distribution of types of presentation was broadly similar in SwiFT to that seen in Australia and New Zealand. The majority (90% in SwiFT, 83% in Australia and New Zealand) had a respiratory

TABLE 15 *Presentation for confirmed H1N1 cases from SwiFT compared with international wave 1 H1N1 pandemic cohorts*

	SwiFT (*N* = 537)	Australia and New Zealand (*N* = 689)	Spain (*N* = 32)
Presentation,* n *(%)			
Viral pneumonitis/ARDS	224 (41.7)	336 (48.8)	29 (90.6)
Secondary bacterial pneumonia	164 (30.5)	140 (20.3)	1 (3.1)
Exacerbation of airflow limitation	95 (17.7)	95 (13.8)	2 (6.3)
Intercurrent illness with H1N1	54 (10.1)	118 (17.1)	0 (0.0)

presentation. The Spanish cohort represented almost exclusively primary viral pneumonia.

In SwiFT, the SOFA score was calculated daily throughout critical care for confirmed H1N1 cases, allowing for a full description of the trajectory of illness. Mean SOFA score on the first day of critical care was reported in Canada, Mexico and Spain (*Figure 21*). In Canada and Mexico, this was also reported on days 4 and 7. The trajectory of illness in SwiFT was similar to that in Canada and ran parallel to, although lower than, that in Mexico. SOFA scores, split by critical care survivors and non-survivors, were reported in Canada and Mexico on day 1 only (*Figure 22*). The day 1 SOFA score was higher in non-survivors than survivors in all countries. In SwiFT, the SOFA score increased and then remained high for non-survivors, but decreased in survivors. *Figures 23* and *24* show individual trajectories for five randomly selected survivors and non-survivors, respectively.

Mortality was reported at various time points in the different countries (*Table 16*). Mortality in SwiFT was similar to that reported for Spain, slightly higher than for Australia and New Zealand (although a significant proportion remained in hospital at the point of analysis) or Canada, and lower than for Mexico.

Duration of critical care was reported for Australia and New Zealand and Canada for all patients, and for Canada and Mexico split by hospital survivors and non-survivors (*Table 17*). Median duration of critical care was long in all countries, and was slightly longer for survivors than non-survivors. Reported duration of critical care was shorter for Australia and New Zealand, but this was calculated on complete cases and excluded a considerable proportion of patients who were still in hospital, which would potentially include longer-staying patients. Invasive mechanical ventilation was received by between 65% and 83% of cases in different countries with duration of mechanical ventilation similar to the total duration of critical care (*Table 18*).

Discussion

SwiFT patients were similar to reported, confirmed wave 1 H1N1 cases identified through the CMP in terms of age, sex and pregnancy status. The markedly different distribution of ethnicity in the wave 1 data was likely to represent early hot spots in the West Midlands and London, and the distribution of ethnicity in SwiFT was similar to that typically observed among critical care admissions more generally. The H1N1 cases from both waves were markedly younger than usual, seasonal critical care unit admissions with either viral or bacterial pneumonia. By comparison with seasonal admissions, a much higher proportion of H1N1 cases were either currently or recently pregnant. This difference will be due in part to the difference in age distribution, but may also reflect an increased risk of infection with H1N1 among pregnant women, an increased response to the infection,[34] and/or a lower threshold for admission.[39]

Early contact during the development of SwiFT with investigators in other countries helped to ensure a common core data set for collection, enabling comparisons across the different settings.[2] There was some variation in inclusion criteria across the different international cohorts, in terms of the definitions of both H1N1 and critical illness. Only a very small number of 'probable' H1N1 cases were included in Canada. However, in Mexico, half of all cases were either 'probable' or 'suspected'. In SwiFT, 59% of patients initially suspected were subsequently tested negative. However, the availability of testing was much less in Mexico, so it is likely that a higher proportion of the 'suspected' cases would actually have had H1N1.

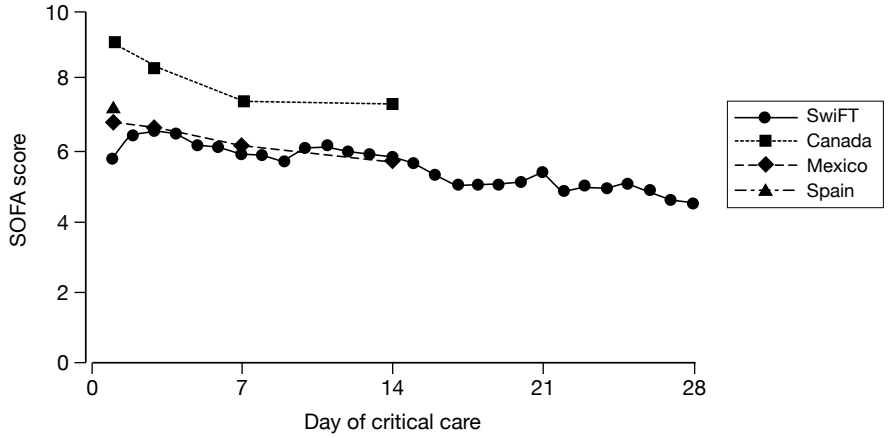

FIGURE 21 *Mean daily SOFA score among patients surviving to that day of critical care.*

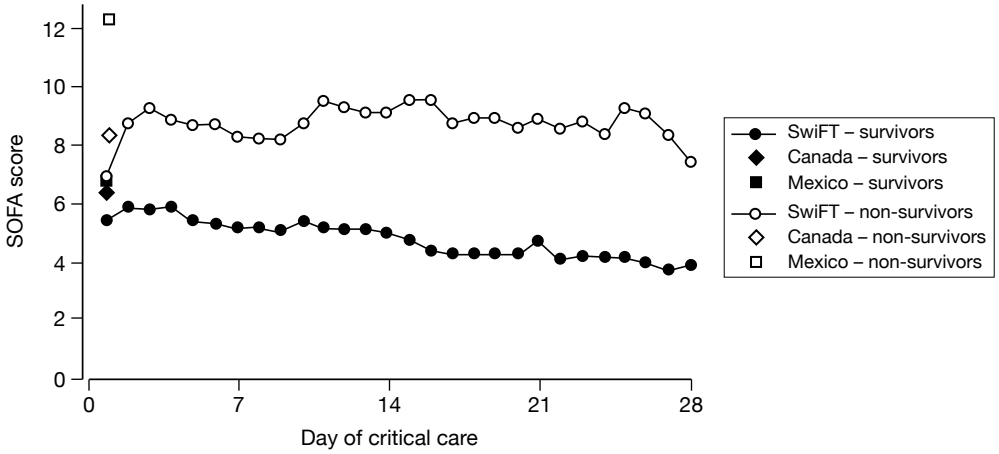

FIGURE 22 *Mean daily SOFA score among patients surviving to that day of critical care split by critical care survival (SwiFT) or hospital survival (Canada/Mexico).*

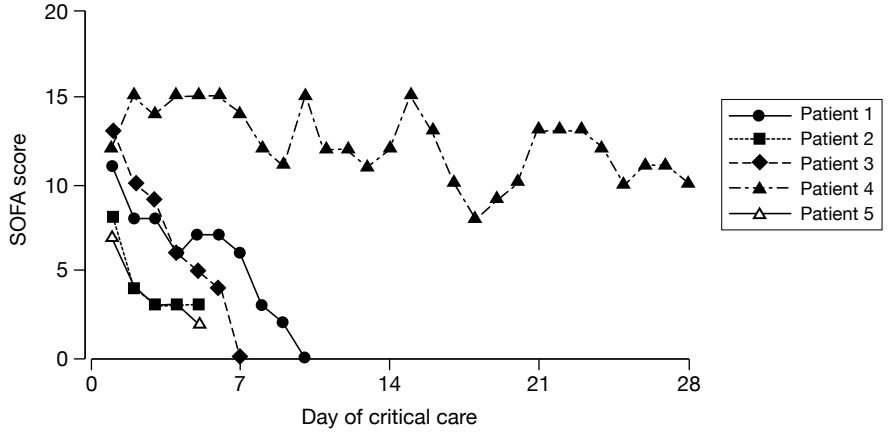

FIGURE 23 *Daily SOFA score for five randomly selected survivors.*

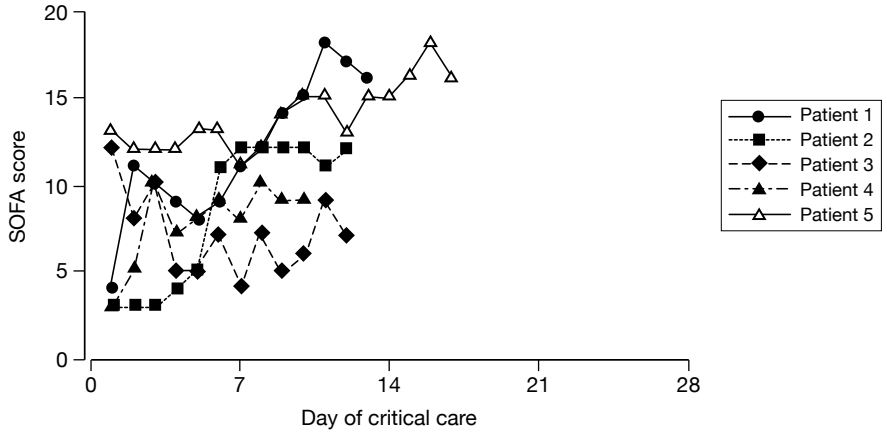

FIGURE 24 *Daily SOFA score for five randomly selected non-survivors.*

TABLE 16 *Outcome for confirmed H1N1 cases from SwiFT compared with international wave 1 H1N1 pandemic cohorts*

Mortality at time point, *n* (%)	SwiFT (*N* = 537)	Australia and New Zealand (*N* = 608)	Canada (*N* = 168)	Mexico (*N* = 58)	Spain (*N* = 32)
End of critical care	114 (21.2)	–	28 (16.7)	–	–
Hospital discharge	–	103 (16.9)[a]	29 (17.3)	24 (41.4)	8 (25.0)
Day 14	87 (16.2)[b]	–	18 (10.7)[c]	19 (32.8)[c]	–
Day 28	103 (19.2)[b]	–	24 (14.3)[c]	23 (39.7)[c]	6 (18.8)[c]
Day 60	113 (21.0)[b]	–	–	24 (41.4)[c]	–
Day 90	113 (21.0)[b]	–	29 (17.3)[c]	–	–

a Excluding 114 patients (15.8%) still in hospital at the point of analysis, including 37 (5.1%) still receiving critical care.
b Deaths while receiving critical care only.
c Deaths in hospital only.

TABLE 17 *Duration of critical care for confirmed H1N1 cases from SwiFT compared with international wave 1 H1N1 pandemic cohorts*

	SwiFT (*n* = 547)	Australia and New Zealand (*n* = 575)	Canada (*n* = 168)	Mexico (*n* = 58)
Duration of critical care (calendar days), median (IQR)				
All	10 (5 to 19)	8 (3 to 16)	12 (5 to 20)	–
Survivors	10 (5 to 20)	–	12 (5 to 22)	14 (6 to 24)
Non-survivors	9 (4 to 15)	–	10 (4 to 19)	7 (2 to 13)

The reports from Australia and New Zealand and from Spain were limited only to patients admitted to intensive care units (and, in the case of Spain, only to adult patients). For Canada and Mexico, patients were also included if they received specific critical care interventions outside of an intensive care unit. SwiFT had the most inclusive criteria, recruiting all patients referred and assessed as requiring critical care (under usual/non-pandemic circumstances), regardless of whether/where critical care was delivered. However, as the magnitude of the pandemic was not as great as feared and consequently most patients received critical care in a critical care unit, these differences in definitions will have had little effect.

TABLE 18 *Mechanical ventilation for confirmed H1N1 cases from SwiFT compared with international wave 1 H1N1 pandemic cohorts*

	SwiFT (*N* = 547)	**Australia and New Zealand (*N* = 706)**	**Canada (*N* = 168)**	**Mexico (*N* = 58)**	**Spain (*N* = 32)**
Mechanical ventilation*, n *(%)	***421 (77.0)***	***456 (64.6)***	***128 (76.2)***	***48 (82.8)***	***22 (68.8)***
Duration (days), median (IQR)					
All	9 (4 to 17)	8 (4 to 16)	12 (6 to 20)	–	–
Survivors	10 (4 to 17)	–	12 (6 to 20)	15 (8 to 26)	–
Non-survivors	8 (4 to 15)	–	12 (4 to 20)	8 (3 to 14)	–

The demographics of critically ill H1N1 cases were broadly similar across all the countries. The exception to this was for obesity, which the reports from wave 1 in other countries suggested was a major risk factor for severe complications of H1N1. In SwiFT, only 24% of confirmed H1N1 cases were reported to be obese. This compares with a figure of approximately 25% from the *Health Survey for England 2008*.[43] Mortality varied across countries from around 17% to 41%, although part of this variation may have been due to lack of standardisation in the time points at which mortality was reported.

Chapter 5
Conclusions

To everyone's relief, H1N1 did not overwhelm critical care services in the NHS. SwiFT did, however, highlight a number of issues for discussion, some with future implications for health care and priorities for research.

SwiFT indicated that, in some acute hospitals in some of the countries, research could be set up rapidly to provide information, early on in a pandemic, to guide critical care clinicians and policy-makers. However, a number of factors played an important role.

First, the ICNARC's existing capacity, expertise and networks should not be underestimated, even with accelerated procedures for central research and information governance. The experienced staff and established processes and expertise at the ICNARC allowed for the rapid institution of SwiFT and, without this 'rolling start', the results of SwiFT may well not have been achieved. If similar capacity, expertise and networks do not exist in other areas, where acute and emergency care will be delivered in a pandemic, the results of SwiFT cannot be considered to be generalisable and there is no room for complacency.

Second, for SwiFT, each of the five countries responded, with varying degrees of success, in achieving research and information governance approvals. It was clear that the current research governance systems vary among countries and some appeared much better able to react to the need for a rapid study of an evolving health-care issue. Research governance systems appeared more effective in those countries with centralised systems, namely England and Scotland. However, even in the light of recent advances, research governance is often a major barrier to the conduct of research, for researchers, and the best examples achieved in SwiFT should be the norm and not the exception, if research that matters to patients is going to be delivered. All should strive to become more able to rapidly process research, especially research that is time-sensitive.

Third, securing local resources appeared to be the main key to participation. It should be noted that it took almost 2 months, following the secure, web-based data entry system going 'live' on 17 September 2009, for comprehensive coverage – SwiFT figures did not equal weekly prevalence figures published by the HPA (for England) until the week commencing 9 December 2009. It appeared that, even in England where local resources were supposedly available, individuals at the local level did not appear to know how to access them. This may be because the CLRN system is new, but anecdotal experience suggests that provision is not standard across CLRNs. Improved access to local resources for supporting research (particularly outside England) should be a high priority.

In conclusion, even with the ICNARC's existing capacity, expertise and networks, a Herculean effort and accelerated procedures for governance, the effort and time scale involved in obtaining approvals were unacceptable during a pandemic. There was considerable variation in procedures (including inconsistency in ethics advice between England and Scotland) and in local resources available across the five countries which added to the complexity of the process and inhibited this collaborative research.

Implication for health care 1: Efforts should be continued to further streamline the current research and information governance procedures and access to local resources required for establishing a research study of benefit to patients, both within and across countries, whether during a pandemic, or not.

More generally, a review of the utility and value of information provided (both during and after the pandemic) to clinicians and policy-makers from the commissioned/funded H1N1 research should be conducted. More specifically to SwiFT, whether the balance was achieved correctly, in terms of required data for SwiFT, should be revisited. It is clear from the amount of data that were subsequently entered into the SwiFT database after the end of the study, that the data requested, specifically the daily data, may have overwhelmed the available resources. In addition, were the reports useful to both clinicians and policy-makers, interaction with the latter

indicated such, but clinical feedback should be elicited.

Implication for health care 2: A review of the utility and value of information provided (both during and after the pandemic) to clinicians and policy-makers from the commissioned/funded H1N1 research should be conducted (to include SwiFT) to learn both the generic and specific lessons prior to future pandemics.

SwiFT proposed longer-term follow-up using linkage to national death registration. Unfortunately, such linkage is not currently available using NHS Number. Algorithms for linkage to the NHS Central Register using NHS Number, without the need for patient names, are currently being developed by the NHS Information Centre and planned to be in operation by the end of 2010, recently extended to the end of 2011.

Implication for health care 3: The availability of a system to link using NHS Number should remain a high priority to inform health-care outcomes.

Triage could be required at several steps in the care pathway for patients in a pandemic: first, in primary care, to determine which patients required hospital assessment; second, in the emergency department, to determine which patients needed hospital admission; and third, in hospital, to determine which patients needed critical care. These three triage steps require different triage thresholds and, most probably, different triage models. SwiFT considered only the third step in the care pathway for H1N1 patients – the decision to admit to critical care only and, more specifically, identifying which patients not to admit when resources are scarce – from among those who would be admitted under usual (non-pandemic) circumstances.

A simple, physiology-based triage model was developed that had only 'satisfactory' concordance. This simple model outperformed CURB-65 among admissions with acute exacerbations of respiratory illness, and seemed to support similar findings from an emergency department cohort. Severity of illness of H1N1 cases, on initial presentation (as assessed by the CURB-65 score), was remarkably low, with 61% of confirmed H1N1 cases scoring 0 or 1 point. According to the Department of Health guidelines drawn up by the British Thoracic Society, British Infection Society and HPA (well in advance of the current pandemic), such patients would be triaged for management at home and not even be admitted to hospital.

Implications for health care 4: CURB-65 appeared an unreliable triage tool.

The utility of a score, derived from the simple, physiology-based triage model, to triage patients for critical care in a pandemic seemed to be minimal. While there may be some scope for using triage models during a pandemic, it seemed clear that: these scores/models are not sufficiently discriminatory to be relied upon in isolation; and the resultant savings in terms of critical care unit bed days would not be substantial.

Implication for health care 5: At this time, pandemic planning should not be based on assumptions that a reliable triage tool is available for critical care and the mild nature of the H1N1 pandemic should not induce complacency.

The development of the simple, physiology-based triage model was limited by the available data. In particular, the most extreme physiological measurements from the first 24 hours following admission to a critical care unit, available from the CMPD, were assumed to be representative of pre-admission values that would be used to make a triage decision. Routinely available data on all acute hospital admissions potentially requiring critical care are required to enable a fuller exploration of decision-making around critical care admission. In addition, data on the duration and trajectory of critical illness would enable exploration of triage models to consider earlier discontinuation of critical care for patients initially admitted to critical care.

Implication for health care 6: There is a lack of accurate data to inform usual, non-pandemic, decision-making both around critical care admission and around continuation of critical care treatment, once commenced.

SwiFT successfully collected data on > 1700 critically ill patients who were affected by the H1N1 pandemic, either directly (as a confirmed or suspected H1N1 case) or indirectly through not being admitted to a critical care unit as a result of the pandemic ($n = 3$). The substantial discordance, between the 'reasonable worst-case scenario' and that experienced, underlines the caution that needs to be exercised in accepting modelled data for any new pathogen or for a known pathogen in a new context. To this end, the existing critical care capacity coped – with only a minority of patients experiencing a level of critical care provision lower than in normal, non-pandemic circumstances.

Caution should also be applied in using SwiFT data to model future outbreaks. While SwiFT data would provide reasonably robust estimates for modelling critical care requirements in a subsequent outbreak of an unchanged virus in the UK, it is important to recognise several caveats. First, changes in population immunity (either natural or due to immunisation) may modify disease load, both across the UK and within local communities. Second, these estimates could suffer from substantial inaccuracy if there is a significant change in the antigenicity of the virus. Third, the estimates could be erroneous if applied to a new virus [e.g. H5N1 (avian influenza)]. These considerations make a strong case for even earlier accumulation of data, than that achieved by SwiFT, in the course of any future epidemic.

Implication for health care 7: Caution needs to be exercised in accepting modelled data for any new pathogen or for a known pathogen in a new context.

The markedly different distribution of ethnicity in confirmed wave 1 H1N1 cases, identified through the CMP, with the distribution of ethnicity in confirmed wave 2 H1N1 cases from SwiFT likely represented early hot spots in the West Midlands and London. The distribution of ethnicity for the latter was similar to that typically observed among critical care admissions more generally.

Implications for health care 8: Caution needs to be exercised in interpretation of data early on in an emerging pandemic and it is important to keep policies and messages up to date.

Research recommendations

Clearly, further research into triage modelling, at each step in the care pathway, is a high priority and specifically important for critical care decision-making. Such research should have two main themes: first, the development and validation of triage models; and second, the potential use of such models for critical care decision-making.

With respect to the first theme, given that triage decisions in a pandemic situation should be made for all patients considered for critical care (and not just those afflicted by the pandemic), data for, and research on, developing and testing the utility of triage models for critical care does not require a pandemic situation. However, to develop such triage models requires the collection of accurate data on all acute hospital admissions potentially requiring critical care to enable a fuller exploration of decision-making around critical care admission, and data on the duration and trajectory of critical illness to enable exploration of triage models to consider earlier discontinuation of critical care for patients initially admitted to critical care. In addition to conventional validation of such triage models, validation could also encompass a comparison with subjective clinical decision-making and an assessment of the potential impact of any triage model on future pandemic situations.

Research recommendation 1: Development and validation of triage models to address the research question – what are the best triage models for critical care decision-making?

With respect to the second theme, the use of triage models, there is a need for a much wider public involvement and debate on this issue. This was highlighted in SwiFT, where the North West REC showed considerable disquiet about the potential use of such models without public involvement and debate. It is far better to have public debate around the role of triage modelling in a situation where critical care services become overwhelmed, sooner rather than later, and a pandemic situation is not the best time to be addressing the utility and ethics of triage models in critical care decision-making.

Research recommendation 2: Public involvement and debate around the role of triage modelling in a situation where critical care services become overwhelmed to address the research question – what are the utility and ethics of triage models in critical care decision-making?

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SwiFT would not have happened without the ICNARC staff having risen to the challenge. Phil Restarick led the co-ordination, nobly supported by Keryn Vella, Lucy Lloyd-Scott, Rachael Scott, André Selmer, Ana Weller, Petra Selmer, Emma Wood, Steve Harris, Emma Walmsley, Sarah Corlett, Gemma Schönenberger and Sheila Harvey.

Things had to move fast and we thank Tom Walley, Peter Davidson, Janet Derbyshire, Steve Smye, Mary Cubitt, Adeeba Ashgar, Janet Wisley, Joan Kirkbride, Alastair Nicholson and, particularly, Lena Petterson for helping this to happen.

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Accessing local resources was key to hospitals participating in SwiFT and we thank the members of the NIHR CRN Critical Care Specialty Group and the Directors and Lead Research Management & Governance Managers at all CLRNs for their support.

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Contribution of authors

Kathryn M Rowan (Director of ICNARC and Honorary Professor of Health Services Research) conceived, designed and led the study, contributed to acquisition, analyses and interpretation of the data, drafted and revised the manuscript and provided final approval of the version to be published.

David A Harrison (Senior Statistician and Honorary Senior Lecturer in medical statistics) conceived and designed the study, contributed to acquisition, analyses and interpretation of the data, drafted and revised the manuscript and provided final approval of the version to be published.

Timothy S Walsh (Consultant, Anaesthesia and Critical Care) substantially contributed to acquisition of data, revised the manuscript and provided final approval of the version to be published.

Daniel F McAuley (Professor and Consultant, Intensive Care Medicine) contributed to development of the data set and acquisition of data, revised the manuscript and provided final approval of the version to be published.

Gavin D Perkins (Associate Clinical Professor, Critical Care) contributed to development of the data set and acquisition of data, revised the manuscript and provided final approval of the version to be published.

Bruce L Taylor (Consultant, Intensive Care Medicine) contributed to acquisition of data, revised the manuscript and provided final approval of the version to be published.

David K Menon (Professor and Consultant, Neurocritical Care) contributed to development of the data set and acquisition of data, revised the manuscript and provided final approval of the version to be published.

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Appendix 1
SwiFT approvals

NIGB

Ethics and Confidentiality Committee

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30 July 2009

Dear Keryn

Re: Application for extension of Case Mix Programme (PIAG2-10(f)/2005) for data collection for SwiFT (Swine Flu Triage) Study

Thank you for applying for support under section 251 of the NHS Act 2006 to process patient identifiable information without consent. This application for extension of section 251 support was considered by the Chair of the Ethics and Confidentiality Committee on 29 July 2009.

The Committee accepted that this was undoubtedly an extension of the current work undertaken by ICNARC and the proposed study used the same methodology adopted by other studies in the Case Mix Programme. The Committee was pleased to note that the proposal for the extension was well developed and clear and appreciated the urgent nature of this work.

As such, I am pleased to inform you that this extension request of PIAG2-10(f)/2005) for data collection by ICNARC for the SwiFT study was approved, subject to confirmation of satisfactory REC approval to the NIGB office.

Conditions of Approval

1. Confirmation of satisfactory REC approval to be submitted to the NIGB Office.
2. This extension has been approved until the official end of the pandemic.

I will arrange for the Register of approved activities to be shortly updated on our website http://www.nigb.nhs.uk/ecc/register-1/register-of-approved-applications to include this extension.

Annual Review

Please note that your approval is subject to submission of an annual review report to show how you have met the above conditions or report plans, and action towards meeting them. It is also your responsibility to submit this report on the anniversary of your final approval and to report any

NIGB

Ethics and Confidentiality Committee

changes such as to the purpose or design of the proposed activity, or to security and confidentiality arrangements.

If you have any queries please get in touch. I would be grateful if you could quote the above reference number, in full, in all future correspondence.

Yours Sincerely

Claire Edgeworth
Approvals Officer

National Information Governance Board for Health and Social Care

NHS
National Institute for Health Research

NIHR Clinical Research Network
Coordinating Centre
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21st August 2009

Professor Kathryn M Rowan
ICNARC
Tavistock House
Tavistock Square
London
WC1H 9HR

Dear Professor Rowan

Re: The Swine Flu Triage (SwiFT) study: Development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic
(IRAS Ref: 29928)

The study detailed above has now proceeded through National Institute for Health Research Coordinated System for Gaining NHS Permission (NIHR CSP) successfully and I am pleased to confirm that it is eligible for inclusion on the National Institute for Health Research Clinical Research Network (NIHR CRN) Portfolio.

Please note that recruitment/accrual study data must be uploaded every month as a condition to be on the NIHR CRN Portfolio. Please be aware that accrual data is monitored and the CLRNs are notified if the study is not uploading accrual data.

It is your responsibility to:

- identify and forward (by return post and/or email) the name and contact details of the person who will be responsible for uploading the accrual data for your study. The named person is referred to as the 'accrual contact'
- ensure that the accrual contact uploads recruitment/accrual data regularly on a monthly basis. Reported accrual activity ultimately informs the allocation of funding for NHS support
- confirm whether the study is open to new sites. This information is extremely important to the successful development of studies.

We will then:

- enter the study on the NIHR CRN Portfolio upon the receipt of accrual contact's details
- forward an accrual data package with detailed instructions on how to upload the data to the accrual contact.

Thank you for your support in this process which will be critical to the successful development of NIHR CRN Portfolio. Our aim is to ensure the provision of high

quality infrastructure to support clinical research in the NHS and support the delivery of your study.

Please do not hesitate to contact me should you require further information

Best Wishes

Dr Sam Taylor
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North West Research Ethics Committee
NHS North West
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18 August 2009

Professor K M Rowan
Director
ICNARC
Tavistock House
Tavistock Square
LONDON
WC1H 9HR

Dear Professor Rowan

Full title of study: **The Swine Flu Triage (SwiFT) study: Development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic**
REC reference number: **09/H1010/58**

The North West Research Ethics Committee reviewed the above application at the meeting held on 11 August 2009. Thank you for attending to discuss the study.

Documents reviewed

The documents reviewed at the meeting were:

Document	***Version***	***Date***
Covering Letter - from Professor Kathy Rowan		07 August 2009
Application	IRAS Version 2.3	07 August 2009
Investigator CV - for Professor Kathryn M Rowan		04 August 2009
Protocol	1.3	03 August 2009
Patient Information Leaflet	1	07 August 2009
Patient Information Poster	1	07 August 2009
Compensation Arrangements: Professional Liability Insurance Certificate - No: A05305/0808		27 August 2008
Letter from Sponsor - from Keryn Vella, Operations Director, ICNARC		04 August 2009
Letter from funder - NIHR Health Technology Assessment programme		27 July 2009
Referees' Reports		
Letter confirming approval from the National Information Governance Board for Health and Social Care (NIGB)		30 July 2009
Spreadsheet of Research Sites		

Provisional opinion

Estimates of the likely impact of the H1N1 swine influenza pandemic on critical care suggest that current critical care resources could be overwhelmed. Latest figures have shown that hospital admissions for H1N1 swine influenza have been rising and, of these, an increasing proportion of patients are being admitted to critical care. It is estimated that there will be a surge in critical care admissions as a result of H1N1 swine influenza during autumn 2009.

In the event that demand for critical care services outstrips provision, triage of patients referred for critical care will become essential.

Existing, proposed tools for triage of patients considered for critical care may not be appropriate for use in the current pandemic due to several factors, as follows: -

1. Many triage tools rely on data relating to chronic health conditions, which may be difficult to assess reliably during the peak of the pandemic.
2. Many triage tools use laboratory parameters, the measurement of which will be resource−intensive and may delay a triage decision.
3. Some triage tools are based around existing risk models for respiratory illness such as pneumonia; however, triage decisions will need to be made for all patients considered for critical care (not only those with influenza) since all patients must share a single pool of resources.
4. Finally, none of the existing triage tools have been developed or evaluated using multi-centre data from the NHS.

In light of these difficulties with existing tools, it is necessary to develop another, more specific, triage tool, which will be based on previous efforts. Whilst being simple enough to be applied quickly and consistently during the peak of the pandemic, it should also be complex enough to adjust the decision criteria in order to match demand against capacity and match inevitable staff shortages (from staff sickness as well as increased demand) and suboptimal staff expertise (arising from the need to redeploy staff to critical care) against the actual clinical demands posed by patients.

The SwiFT study thus aims to develop a triage tool to guide immediate policy and practice during the H1N1 swine influenza pandemic in order to deliver the best possible care to critically ill patients. The intention is to develop and implement a UK−wide, real-time high quality clinical database of adult and paediatric patients with confirmed or suspected H1N1 swine influenza referred for critical care. The proposed data collection will allow policy makers within the NHS to assess, in real-time, the burden of severe H1N1 swine influenza and to rapidly respond to escalation in the number of severe cases.

All patients (adult and paediatric) that are referred for critical care, and who would be admitted in "usual" circumstances, and have either confirmed or suspected H1N1 swine influenza, or are refused critical care or receive critical care outside a critical care unit as a direct or indirect result of the pandemic, will be eligible for the study.

Patients will be identified by the direct treating health care teams. Information posters and leaflets will be made available in all participating centres to inform participants and their relatives / friends that the centre is participating in the study, that this does not affect their treatment in any way, and that any participant (or relative / friend on their behalf) is free to withdraw their data from the study at any time without affecting future care.

Patients will not receive any treatment above and beyond what is considered appropriate care by the critical care staff at the hospital.

Patient data, which are routinely collected and recorded in hospital notes, will be abstracted and entered into a secure web portal by local data collection staff and sent to the Intensive Care National Audit and Research Centre (ICNARC) for analysis.

The data will be analysed weekly in order to refine the triage tools, and to provide weekly reports to the Department of Health and to participating centres.

The Committee noted that the proposed study had received approval from the National Information Governance Board for Health and Social Care (NIGB) to process identifiable patient data without consent (under section 251 of the NHS Act 2006). It was acknowledged that this approval meant that under the terms of the Mental Capacity Act (MCA) the proposed study was not considered to be 'intrusive' and consequently the research provisions of the MCA did not apply.

The REC raised a number of queries/concerns in relation to the application and it was agreed that it would be helpful to speak to Dr Harrison (Senior Statistician and Key Investigator / Collaborator on the study), who had attended the meeting to answer any queries in person.

The Chair thanked Dr Harrison for attending the meeting and the following points were raised: -

The Committee noted that four Referee Assessment reports had been provided with the submission and the REC queried to what extent the current application had been changed as a result of the comments raised by these referees.

Dr Harrison explained that the Study Board had considered all of the comments raised by the referees and had addressed some of the issues raised by them (but not all).

The REC questioned the level of service user involvement in the current application.

Dr Harrison informed Members that there were two service user representatives on the study group (both charity trustees on ICNARC's Board of Management and both ex-critical care patients). They would be involved in the progress of the study as it moved forward.

Members noted that the study was described as being non-interventional and confirmation was sought that patients, whose data would be collected as part of the study, would receive only routine clinical care and no additional interventions, i.e. the study would involve only the collection of their data.

Dr Harrison confirmed that this was correct.

Clarification was sought as to how the stated rationale, science and design of the proposed study would inform triage decisions.

Dr Harrison informed Members that the current proposed study would establish a very large database of adult and paediatric patients with confirmed or suspected H1N1 swine influenza who are referred for clinical care. The study would use data from a real-time model and would then test the model and look at refinements. It was intended that the developed models would provide the ability to triage either all patients referred for critical care, or only those patients referred for critical care with confirmed or suspected H1N1 swine influenza.

The Committee noted that approval had been obtained from NIGB for the study team to process patient identifiable information without consent. However, this did not negate the need to provide sufficient information to patients about the study. It was felt that issues around the study were not reflected sufficiently in the study information leaflet

and poster. For example, future limitations in terms of service provision leading to rationing of treatment / resources, and the challenges faced by the NHS.

These concerns would be detailed in writing to the Chief Investigator in the formal letter of response from the North West REC following the meeting.

In addition to the above, it was pointed out that ordinarily, the REC would expect to see a specific named contact at each hospital being included on the information leaflet / poster.

Dr Harrison explained that the study team wished to use a generic information leaflet at all study sites and pointed out that personnel at each site would be aware of the study and would also know who their local contact was in order to direct patients to them if/as required.

The Chair reiterated that it would not be too difficult to include details of the local contact in the information leaflet.

This point was accepted.

The REC questioned whether the information leaflet and poster accurately reflected the aims of the study and in particular the use of the patient data collected to develop triage tools.

Dr Harrison informed Members that the study team would use pre-pandemic data to develop an initial triage model. The Department of Health would then incorporate all patient data (past and ongoing) in order to further develop triage models. He further explained that the current triage model had several limitations not least of which was it's dependence on laboratory data, which was not available for many patients.

The Committee queried whether the two service user representatives on the study group expressed favourable or unfavourable views with regards to the current proposed study.

Dr Harrison confirmed that both service user representatives expressed a favourable view of the current proposed study.

Members sought detail as to the number of patients that would be expected to be unable to consent for themselves through physical or mental incapacity (were consent to be sought).

Dr Harrison provided an estimate of approximately 3% of patients that would be unable to consent for themselves to take part in this study.

The Committee questioned whether the data that would be obtained from the study would be sufficiently sophisticated to enable complex decisions to be made vis-à-vis the development of triage models that would be required in order to 'ration' services.

Dr Harrison pointed out that the study would collect a very large amount of data that would be expected to be sufficient to inform the development of appropriate triage models.

Following on from the above point relating to the possible future rationing of services, the REC expressed concern that the study would not capture information regarding clinical judgement but would only capture physiological patient data.

Dr Harrison informed the REC that the study would collect some data around decisions taken as part of the clinical care received, for example, a decision to discharge a patient due to a shortage of beds etc.

The questioning concluded and Dr Harrison left the meeting.

The Committee would be content to give a favourable ethical opinion of the research, subject to receiving a complete response to the request for further information set out below.

The Committee delegated authority to confirm its final opinion on the application to the Professor R Gulati (Consultant Physician), and Mr R Swindell (Medical Statistician).

Further information or clarification required

Action Points

A. Further to discussion at the meeting, and as stated above, it was agreed that the approval that had been obtained from NIGB for the study team to process patient identifiable information without consent did not negate the need to provide sufficient information to patients about the study. As such it was agreed that the study information leaflet and poster should be amended to more accurately reflect the principal study objective, i.e. the use of patient data to develop triage tools to guide the use of critical care services during the H1N1 swine influenza pandemic. As part of this patients should be informed that the use of triage could prove to be essential in the event that demand for critical care services exceeds available capacity. (Mandatory)

B. Further to discussion at the meeting, and as stated above, the REC would expect to see a specific named contact at each hospital being included on the information leaflet / poster. It was not considered to be sufficient to expect patients to speak to any member of staff in order to obtain information about the local study contact. The Committee appreciates that the study team would wish to use a generic information leaflet /poster at all sites and this would still be possible by means of a blank space on the leaflet / poster for the study site to manually insert details (name, contact number etc.) for their local contact. (Mandatory)

In addition to the above mandatory action points relating to the information leaflet and poster, the North West REC would wish to make a number of comments relating to the proposed study, upon which it respectfully requests that the study team give further consideration (due to the urgent nature of the study, these are suggestions/comments only and approval for the study is not dependent upon a satisfactory response/action): -

- The REC agreed with the concerns raised by a number of the referees regarding possible selection bias in the recruitment of patients into the study and the fact that consideration should be given to the acquisition of data from pre-ICU (intensive care unit) patients.

- The Committee expressed concern with regards to the future introduction of triage models that were likely to be used as rationing tools for healthcare services on the basis of the type of data collected in the current proposed study, i.e. data that takes no account of clinical judgement but focuses solely on physiological data.

- It was pointed out that the introduction of a fixed tool for triage was problematic, as by its very nature, triage must be responsive to the needs of both the service and the patients.

- The Committee supported the view expressed in detail by one of the referees that unless the current swine influenza pandemic is prolonged, the current proposed study is unlikely to result in the production of a scientifically robust and clinically viable triage tool, which

would be made available to, and adopted by clinicians in ICU units across the UK in the future. Furthermore, if future influenza pandemics produce significantly different patterns of morbidity to those produced by the current H1N1 strain, then any tool resulting from the current study would be of limited value.

- The REC felt strongly that the public should be consulted on the use of triage approaches to the allocation of limited critical care resources during the swine influenza pandemic. The rationing of healthcare is an emotive issue and the study team is strongly encouraged to consult the public on the ethical implications of the use of such triage tools (although it is recognised that this would be particularly challenging given the urgency with which the triage tools are to be developed).

When submitting your response to the Committee, please send revised documentation where appropriate underlining the changes you have made and giving revised version numbers and dates.

The Committee will confirm the final ethical opinion within a maximum of 60 days from the date of initial receipt of the application, excluding the time taken by you to respond fully to the above points. A response should be submitted by no later than 16 December 2009.

Membership of the Committee

The members of the Committee who were present at the meeting are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

09/H1010/58	**Please quote this number on all correspondence**

Yours sincerely

Dr Donal Manning
Chair

Email: noel.graham@northwest.nhs.uk

Enclosures: List of names and professions of members who were present at the meeting and those who submitted written comments.

Copies to: -

Ms K Vella
Operations Director
Intensive Care National Audit & Research Centre (ICNARC)
Tavistock House
Tavistock Square
LONDON WC1H 9HR

R&D office for NHS care organisation at lead site: -

Mr S Kelleher
Cambridge University Hospitals NHS Foundation Trust
Research & Development Box 277
Addenbrookes Hospital
Hills Road
CAMBRIDGE
CB2 0QQ

North West Research Ethics Committee

Attendance at Committee meeting on 11 August 2009

Committee Members Present:

Name	*Profession*	*Present*	*Capacity*
Ms Arlene Blanchard	Retired Lecturer / Patient Representative	Yes	Lay
Mr James Bruce	Consultant Paediatric Surgeon	Yes	Expert
Mrs Chris Burgess	Retired Senior Manager - Equal Opportunities Commission	Yes	Lay
Professor Caroline Carlisle	Professor of Education in Nursing and Midwifery – The University of Manchester	Yes	Expert
Dr Sally Furnish	Chartered Clinical Psychologist	Yes	Expert
Professor Ravi S Gulati	Consultant Physician	Yes	Expert
Dr Donal Manning	Consultant Paediatrician	Yes	Expert
Dr Henry C Mwandumba	Consultant Physician	Yes	Expert
Mrs Margaret Norval	Chief Pharmacist	Yes	Expert
Professor Elizabeth Perkins	Director - The Health and Community Care Research Unit - The University of Liverpool	Yes	Lay
Mr Ric Swindell	Medical Statistician	Yes	Expert

Written comments received from:

Name	*Position*
Dr Fiona O'Neill	Medical Sociologist / Bioethicist (Lay)

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Dr Donal Manning
Chair
North West Research Ethics Committee
NHS North West
Room 155 - Gateway House
Piccadilly South
Manchester
M60 7LP

25 August 2009

Dear Dr Manning

Re: REC Ref 09/H1010/58 - The Swine Flu Triage (SwiFT) study

Thank you for your letter of 18 August, 2009. I'm sorry that I wasn't able to attend the meeting of the North West Research Ethics Committee (NWREC) on 11 August 2009 to respond directly to the concerns raised. I am, however, very grateful for the Committee's detailed review and comments.

Prior to my response, I think it is important to be explicit about the origins and context for the SwiFT study. Mid-June, ICNARC was contacted by the Department of Health and "encouraged" to respond to a limited (i.e. just us) tender on the development of a prognostic model/clinical decision rule for the triage of patients being considered for critical care – in the light of the impending H1N1 swine influenza pandemic… Following such "encouragement", the SwiFT study proposal was rapidly developed (within 72-hours) and then funded, following rapid peer review.

Though the proposal needed to address the original request to develop a triage tool (described in our protocol in the first objective), I should point out that the investigators are well aware of the issues and limitations of this single model approach, as highlighted by both the NWREC and the original peer reviewers. However, despite these limitations, we, as investigators, do believe that information to guide (and not determine) both local clinical practice and national policy throughout the pandemic is important and possible from the SwiFT study, as planned.

The term "triage tool(s)", used widely throughout the protocol should be regarded, though is not explicitly stated, as any information that the SwiFT study can provide, either from existing or from new SwiFT study data, to guide (and not determine) both local clinical practice and national policy throughout the pandemic.

I write in response, first, to the important comments raised by the Committee and second, to the mandated Action Points.

Comments

The REC agreed with the concerns raised by a number of referees regarding possible selection bias in the recruitment of patients into the study and the fact that consideration should be given to the acquisition of data from pre-ICU (intensive care unit) patients.

The SwiFT study, as you are aware, has two main objectives:

- the development of triage tools using existing data; and
- the establishment of ongoing H1N1 swine influenza pandemic-related data collection to refine any triage tools (developed on the existing data) and, through regular reporting, to guide practice and policy, both locally and nationally.

The above comment refers to the first objective of SwiFT.

With regard to the development of a single overall model to triage patients being considered for critical care, we agree with the NWREC (and the original peer reviewers/referees…) regarding the possible selection bias in the existing data from the Case Mix Programme Database. We have explained this issue, in response to the peer reviewers, to the funders and indicated that we would use our existing, extensive networks to attempt to identify any existing pre-ICU data (we do hold some pre-ICU critical care outreach assessment data at ICNARC which we will use to help to address this bias).

The Case Mix Programme Database, however, may help to identify (from patients who routinely get critical care in a non-pandemic situation) those patients who may be able to be triaged more safely for critical care delivered in an extended critical care area (created as surge capacity) or a non-critical care area (i.e. those receiving only basic respiratory and/or basic cardiovascular organ support etc.) during the pandemic from those who will require major, multiple organ support. The Case Mix Programme Database may also help in planning use of critical care resources by indicating expected duration of critical care required by typical seasonal admissions.

Finally, the planned new SwiFT study data includes data available at the point that patients are referred and assessed as requiring critical care.

The Committee expressed concern with regards to the future introduction of triage models that were likely to be used as rationing tools for healthcare services on the basis of the type of data collected in the current study, i.e. data that takes no account of clinical judgement but focuses solely on physiological data.

We recognise that the SwiFT study will not produce a single triage model to be used to ration critical care services. It is hoped though, that the SwiFT study, using both existing and new SwiFT data, will provide information to guide (and not determine…) optimal use of critical care services throughout the pandemic. My personal history of working with critical care doctors and nurses in the context of risk prediction models for hospital mortality, over the past 22 years, indicates to me that they are used to using such information solely as an adjunct to their clinical judgement.

It was pointed out that the introduction of a fixed tool for triage was problematic, as by its very nature, triage must be responsive to the needs of both the service and the patients.

We agree and the SwiFT study has no intention of providing such a fixed tool.

The Committee supported the view expressed in detail by one of the referees that unless the current swine influenza pandemic is prolonged, the current proposed study is unlikely to result in the production of a scientifically robust and clinically viable triage tool, which would be made available to, and adopted by clinicians in ICU units across the UK in future. Furthermore, if future influenza pandemics produce significantly different patterns of morbidity to those produced by the current H1N1 strain, then any tool resulting from the current study would be of limited value.

These views are rightly related, and noted, to the notion that the SwiFT study will produce a single triage tool. For the reasons outlined above, we do not see this being the case. It is, however, hoped that information derived from the SwiFT study will inform optimal use of critical care services during the pandemic. For example, at this stage, there is little to no collective experience of the characteristics, treatment, outcome, duration of critical care etc. for H1N1 swine influenza cases and the SwiFT study will endeavour to provide these to clinicians, as early as possible, to inform clinical care of these patients.

The REC felt strongly that the public should be consulted on the use of triage approaches to the allocation of limited critical care resources during the swine influenza pandemic. The rationing of healthcare is an emotive issue and the study team is strongly encouraged to consult the public on the ethical implications of the use of such triage tools (although it is recognised that this would be particularly challenging given the urgency with which the triage tools are to be developed).

ICNARC has previously funded and collaborated in research investigating survivors' and family/close friends' experiences of critical care (see: http://www.healthtalkonline.org/Intensive_care/). I am happy to approach the DIPEx research group with a view to addressing this issue, however, as noted by the NWREC, time (and resources) for this are scant. Should the SwiFT study lead to the development of a valid, single overall triage tool, I will ensure that the NWREC's concerns regarding public consultation are conveyed at/to the highest level.

Action Points

I have amended the Patient Information Leaflet and Patient Information Poster both to more accurately reflect the principal study objectives and to ensure that a blank space is available for manual insertion of the details (name/contact number) for the Local Collaborator. We will also ensure that instructions are provided for completion of these details.

Finally, in conclusion, SwiFT is intended to be a responsive, real-time study aiming to support the needs of critically ill patients while taking into account NHS resources for critical care and the likely strain on these NHS resources.

Once again, thank you for the Committee's detailed review and comments.

Yours sincerely

Professor Kathy Rowan
Director

Encs

Northwest 5 Research Ethics Committee – Haydock Park
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Room 155 - Gateway House
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02 September 2009

Professor K M Rowan
Director
ICNARC
Tavistock House
Tavistock Square
LONDON
WC1H 9HR

Dear Professor Rowan

Full title of study:	**The Swine Flu Triage (SwiFT) study: Development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic**
REC reference number:	**09/H1010/58**

Thank you for your letter of 25 August 2009, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by Professor R Gulati (Consultant Physician), and Mr R Swindell (Medical Statistician).

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation [as revised], subject to the conditions specified below.

Mental Capacity Act 2005

The committee did not approve this research project for the purposes of the Mental Capacity Act 2005. The research may not be carried out on, or in relation to, a person who lacks capacity to consent to taking part in the project. The rationale for this is that the proposed study has received approval from the National Information Governance Board for Health and Social Care (NIGB) to process identifiable patient data without consent (under section 251 of the NHS Act 2006). This approval means that under the terms of the Mental Capacity Act (MCA) the proposed study is not considered to be 'intrusive' and consequently the research provisions of the MCA do not apply.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

For NHS research sites only, management permission for research ("R&D approval") should be obtained from the relevant care organisation(s) in accordance with NHS research governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk. *Where the only involvement of the NHS organisation is as a Participant Identification Centre, management permission for research is not required but the R&D office should be notified of the study. Guidance should be sought from the R&D office where necessary.*

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	***Version***	***Date***
Covering Letter - from Professor Kathy Rowan		07 August 2009
Application	IRAS Version 2.3	07 August 2009
Investigator CV - for Professor Kathryn M Rowan		04 August 2009
Protocol	1.3	03 August 2009
Patient Information Poster	1	07 August 2009
Compensation Arrangements: Professional Liability Insurance Certificate - No: A05305/0808		27 August 2008
Letter from Sponsor - from Keryn Vella, Operations Director, ICNARC		04 August 2009
Letter from funder - NIHR Health Technology Assessment programme		27 July 2009
Referees' Reports		
Letter confirming approval from the National Information Governance Board for Health and Social Care (NIGB)		30 July 2009
Spreadsheet of Research Sites		
Response to Request for Further Information: From Professor Kathy Rowan		25 August 2009
Participant Information Sheet: Patient Information Leaflet	3	25 August 2009
Advertisement: Patient Information Poster	3	25 August 2009

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Service website > After Review

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email:

referencegroup@nres.npsa.nhs.uk.

09/H1010/58	**Please quote this number on all correspondence**

Yours sincerely

Dr Donal Manning
Chair

Email: noel.graham@northwest.nhs.uk

Enclosures: "After ethical review – guidance for researchers"

Copies to:

Ms K Vella
Operations Director
Intensive Care National Audit & Research Centre (ICNARC)
Tavistock House
Tavistock Square
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R&D office for NHS care organisation at lead site: -

Mr S Kelleher
Cambridge University Hospitals NHS Foundation Trust
Research & Development Box 277
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CB2 0QQ

From: Stephen Smye [mailto:S.W.Smye@Leeds.ac.uk]
Sent: 30 July 2009 09:07
To: David Harrison
Subject: Re: SwiFT: follow-up to teleconference

David,

fyi - please see message below, sent yesterday.

best wishes
Steve

"Circulation: CLRN Clinical Directors and Senior Managers
Lead RM&G Managers
P/TCRN Directors and Assistant Directors

C.C. Adeeba Asghar
Stephen Smye
Jonathan Gower
Christine Oxnard
Carolyn Taylor
John Sitzia
Helen Campbell
Swine Flu Coordinating Group

Dear Colleague

Swine Flu Briefing Paper - CRN 4

In line with network plans for expediting the conduct of swine flu research, we are writing to provide an “early warning” of major swine flu studies that will be rolled out nationally across all CLRNs. It is likely that these studies will require set up and NHS permission through CSP throughout August with many starting in early September.

We will be setting up a reporting system to facilitate communication between CLRNs tasked with delivery of these studies and the Coordinating Centre so that we can provide support and assistance. We will provide a weekly summary of the swine flu studies we are expediting through the networks so that networks can be clear which studies to prioritise.

The Swine Flu Triage study (SwiFT): Development of ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic.

Chief Investigator: Prof. Kathy Rowan, Intensive Care National Audit and Research Centre (ICNARC)

Study coordinator: Phil Restarick, Intensive Care National Audit and Research Centre (ICNARC)

Lead CLRN: West Anglia.

The study requires data collection for patients with swine flu on Intensive Care Units and national coverage is expected. Whilst details of the data sets (and costs of data collection) are still being developed, it will be very helpful if each CCRN network team reviewed the capacity of the Intensive Care Units to collect this data and, where such capacity is limited, plan to put in place adequate capacity. Many Intensive Care Units already work with ICNARC on similar work as part of ITU audits.

Clearly this is challenging as details of the study and numbers of patients are not clear. However, helpful approaches may include considering

Cover from pool of CLRN research nurses or other appropriate research staff, including data officers
Cover from staff for adjacent CLRN pools of research staff
Cover from staff from adjacent P/TCRN Local Research Networks
Overtime payments for existing staff on ICU
Increasing hours of part-time staff on ICU
Using bank staff

Funding for the data collection exercise will be available from the national contingency if required.

We recognise that any assessment of capacity will simply be an estimate and subject to change in the light of future study details, but it would also be very helpful if you could provide details of the capacity for your network to undertake the data collection by emailing these details direct to Carolyn Taylor at carolyn.l.taylor@nihr.ac.uk. as soon as possible.

As with all of our other Swine Flu correspondence we would be most grateful if you could cascade this information across all of your Clinical Research Networks as appropriate.

Kind regards

Nicki

Gill Thackrah
PA to Dr Nicki Latham, Director of Corporate Affairs
National Institute for Health Research
Clinical Research Network Coordinating Centre (NIHR CRN CC)
Fairbairn House
71 -75 Clarendon Road
Leeds
LS2 9PH

Tel: 0113 343 0437
Fax: 0113 343 2300
Email: gillian.e.thackrah@nihr.ac.uk
www.crncc.nihr.ac.uk

From the Chief Medical Officer
Dr Michael McBride

Department of
Health, Social Services and Public Safety
www.dhsspsni.gov.uk
AN ROINN
Sláinte, Seirbhísí Sóisialta agus Sábháilteachta Poiblí
MÄNNYSTRIE O
Poustie, Resydènter Heisin an Fowk Siccar

Chief Executives, Health & Social Care Trusts

Castle Buildings
Stormont Estate
Belfast BT4 3SQ
Tel: 028 90 520658
Fax: 028 90 520574
Email:michael.mcbride@dhsspsni.gov.uk

Your Ref:
Our Ref:
Date: 25 August 2009

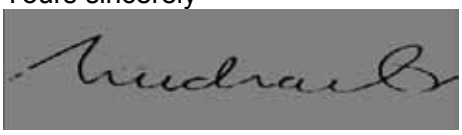
Dear Colleague

ICNARC – SwiFT Study: HOLDING PATIENT IDENTIFIABLE DATA FROM CRITICAL CARE UNITS (N IRELAND) DURING SWINE FLU PANDEMIC

In relation to ICNARC's proposed SwiFT Study, the National Information Governance Board (NIGB) has given approval to hold patient identifiable data from English and Welsh Intensive Care Units. NIGB does not apply to Northern Ireland nor is there equivalent legislation here so patient consent would normally be required before personal data could be contributed to a study.

The issue of contributing information to this study has been considered within DHSSPS. Whilst individual organisations and clinicians can still make their own decisions about whether or not they wish to contribute patient data to the study, it is the view of DHSSPS that Northern Ireland should contribute data as the study is very much in the public interest. It will inform policy and clinical practice both locally and nationally and will deliver benefits for service users here. I would encourage you to support this initiative.

Yours sincerely



DR MICHAEL MCBRIDE
Chief Medical Officer

Working for a Healthier People

INVESTOR IN PEOPLE

Scotland A Research Ethics Committee

Secretariat
Deaconess House
148 Pleasance
Edinburgh
EH8 9RS
Telephone 0131 536 9026
Fax 0131 536 9346
www.corec.org.uk

NHS SCOTLAND

0 5 OCT 2009

Professor Kathryn M Rowan
Director
ICNARC
Tavistock House
Tavistock Square
London
WC1H 9HR

Date: 28 September 2009
Your Ref.:
Our Ref.: 09/MRE00/73

Enquiries to: Walter Hunter
Extension: 89026
Direct Line: 0131 536 9026
Email: walter.hunter@lhb.scot.nhs.uk

Dear Professor Rowan

Study title: **The Swine Flu Triage (SwiFT) study: Development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic**

REC reference: **09/MRE00/73**

The Scotland A Research Ethics Committee reviewed the above application at the meeting held on 24 September 2009.

Ethical opinion

The Committee questioned if this application was actually primary research rather than service development. It was crucially linked to service delivery. It did not allow for consent to be obtained for adults lacking capacity in Scotland, as required by the Adults with Incapacity (Scotland) Act 2000. The application did not involve any research being undertaken on patients and did not make clear why identifiable information was required. Most of the data were already collected routinely and passed on daily to ICNARC. The Committee wondered if all the participating sites had agreed to participate-they all appeared to be part of CMP in England and Wales and SICSAG in Scotland. The Committee was of the opinion that this was audit linked to service development and delivery rather than research, and therefore did not require ethical approval from an NHS research ethics committee.

The Committee agreed that under the terms of the Research Governance Framework (RGF) this project was considered to be audit and should not be managed as research.

NHS
SCOTLAND

REC reference number: 09/MRE00/73-Please quote this number on all correspondence

Yours sincerely

WALTER HUNTER
Committee Co-ordinator
cc: Keryn Vella
Operations Director
ICARC
Tavistock House
Tavistock Square
London
WC1H 9HR

Dr Donal Manning
Chairman
North West 5 Research Ethics Committee
Haydock Park
Room 155 - Gateway House
Piccadilly South
Manchester
M60 7LP

Scotland A Research Ethics Committee

Attendance at Committee meeting on 24 September 2009

Committee Members:

Name	Profession	Notes
Professor K Lees	Consultant Physician/Clinical Pharmacologist (Chairman)	
Dr M Booth	Consultant Anaesthetist (Vice Chairman)	
Professor R Anderson	Consultant in Reproductive Medicine	
Miss R McInnes	Lay	
Mr L Moffat	Consultant Urologist	
Mrs A M Peffer	Lay	
Mrs F Pfab	Statistician	
Dr R Quigley	General Practitioner	
Dr A Richardson	Consultant Clinical Psychologist	
Dr C Selby	Consultant Physician	
Miss F Sloan	Lay	
Mrs M Sweetland	Statistician	
Mrs M Thomson	Lay	
Professor N Webster	Honorary Consultant Anaesthetist	

Apologies

Dr S Gregory	Qualitative Researcher
Mrs A Macpherson	Lay
Canon M McManus	Lay
Dr A Munro	Retired General Practitioner
Mrs W Nganasurian	Lay
Professor J Webster	Consultant Physician/Clinical Pharmacologist

Also in attendance:

Name	Position (or reason for attending)
Mr W Hunter	Senior Committee Co-ordinator
Dr A Bailey	Scientific Officer

Chief Medical Officer and Public Health Directorate

T: 0131-244 2320 F: 0131-244 2285
E: alison.spaull@scotland.gsi.gov.uk

The Scottish Government

Circ to:
CEOs NHS Health Boards
Chairmen of RECs
cc. R&D Directors NHS Health Boards
cc. Directors of R&D networks
cc. Research project leaders (Woolhouse, Simpson, Walsh)

Homecoming Scotland 2009
homecomingscotland2009.com

31 August 2009

Dear Colleague

Commissioned Research Projects on Influenza A(H1N1) Virus

The Scottish Govenrment have been liaising closely with the English group commissioning research on the current influenza outbreak to ensure that the key questions are addressed urgently. Three projects are currently agreed and all are obliged to work to tight timescales if their results are to inform the treatment or prevention of the anticipated over-winter rise in case numbers.

We write to ask you to ensure that these projects are given the priority necessary to secure rapid ethical and other appraisals and prompt responses to requests for information, data, samples or assistance from the research teams listed below

Scottish Govenrment are funding work to establish the level of existing immunity to the H1N1 flu virus in the population through Professor Woolhouse ("*Enhanced influenza surveillance in Scotland*".
Professor Simpson's NIHR-funded study ("V*accine effectiveness in pandemic influenza – primary care- VIPER*") will help inform vaccine usage strategies.
Professor Walsh is co-ordinating Scottish participation in The Swine Flu Triage study (SwiFT). The study requires data collection for patients with swine flu on Intensive Care Units and national coverage is expected. Whilst details of the data sets (and costs of data collection) are still being developed, it will be very helpful if each Health Board reviewed the capacity of the Intensive Care Units to collect this data and, where such capacity is limited, plan to put in place adequate capacity.

If necessary, we expect staff funded from any CSO NHS infrastructure budget to assist these projects as a priority over their normal responsibilities. Such requests will not be unreasonably made.

We appreciate your assistance;
Yours sincerely

Harry Burns

Dr Harry Burns
Chief Medical Officer

Alison Spaull

Dr Alison Spaull
Director, Chief Scientist office

St Andrew's House, Regent Road, Edinburgh EH1 3DG
www.scotland.gsi.gov.uk

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Appendix 2
SwiFT data collection form

SwiFT Data Collection Form - add new adult/paediatric patient...

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H1N1

- ☐ Suspected or confirmed
- ☐ Referred and assessed as requiring critical care

Non-H1N1

- ☐ Referred and assessed as requiring critical care (under usual / non-pandemic circumstances)
- ☐ Not admitted to a critical care unit in your hospital due to pandemic

All

NHS number (*or equivalent*):

Date of birth: / /

Sex:
- ☐ Female
- ☐ Male

Hospital number (mandatory):

Ethnicity:
- ☐ White
- ☐ Asian
- ☐ Black
- ☐ Mixed
- ☐ Other
- ☐ Not stated

Body composition:
- ☐ Very thin (BMI <16)
- ☐ Thin (BMI 16-18.5)
- ☐ Acceptable weight (BMI 18.6-24.9)
- ☐ Overweight (BMI 25-29.9)
- ☐ Obese (BMI 30-39.9)
- ☐ Morbidly obese (BMI ≥40)

H1N1 only

Currently or recently pregnant:
- ☐ Currently pregnant
- ☐ Recently pregnant (within last 42 days)
- ☐ Not known to be pregnant

H1N1 status:
- ☐ Suspected
- ☐ Confirmed

H1N1 vaccine:
- ☐ Yes
- ☐ No

Statins:
- ☐ Yes
- ☐ No

Antivirals *(tick all that apply)*:
- ☐ Oseltamivir (Tamiflu®)
- ☐ Zanamivir (Relenza®) inhaled/nebulised
- ☐ Zanamivir (Relenza®) intravenous
- ☐ Ribavirin
- ☐ Peramivir

H1N1 presentation:
- ☐ Viral pneumonitis / ARDS
- ☐ Secondary bacterial pneumonia
- ☐ Exacerbation of airflow limitation
- Intercurrent illness with H1N1 .....

Non-H1N1 only

Primary reason for critical care:

Main condition requiring critical care: .....

Assessment for critical care

NHS number (*or equivalent*):

Hospital number (mandatory):

Assessment details

Date/Time of assessment (mandatory):

/ /

: 24hr

Location of patient at assessment:

- Emergency department ☐
- Ward ☐
- HDU ☐
- Critical care unit ☐
- Extended critical care area ☐
- Other ☐

On assessment

Chronic organ dysfunction (*tick all that apply*):

	Moderate:	Severe:
Respiratory	☐	☐
Cardiovascular	☐	☐
Renal	☐	☐
Hepatic	☐	☐
Neurological	☐	☐
Immunocompromised	☐	

AVPU (*tick one*):

- Alert ☐
- Voice ☐
- Pain ☐
- Unresponsive ☐
- Not assessed ☐

Confused: ☐

On assessment cont.

Vital signs

Temperature: ☐☐.☐ °C **Site:** Central ☐ Non-central ☐ **Not assessed:** ☐

Blood pressure (*systolic/paired diastolic*): ☐☐☐/☐☐☐ mmHg ☐

Heart rate: ☐☐☐ beats min^{-1} ☐

Respiratory rate: ☐☐☐ breaths min^{-1} ☐

Oxygenation **Not assessed:**

O_2 saturation: ☐☐☐ % ☐

FiO_2 : ☐☐☐ % ☐

Test results

(*last prior to assessment within four hours*)

Base excess: + ☐ - ☐ ☐☐.☐ mEq l^{-1} **Not assessed:** ☐

Blood lactate: ☐☐.☐ mmol l^{-1} ☐

Serum urea: ☐☐☐.☐ mmol l^{-1} ☐

Creatine kinase: ☐☐☐☐☐ U l^{-1} ☐

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Outcome

Outcome of assessment:

Critical care (your hospital) ☐ | Critical care (other hospital) ☐ | No critical care ☐

Date/Time critical care commenced:

Date: / /

Time: : 24hr

Receiving hospital (*name*): → END

Main reason for refusal:

- Futility ☐
- Lack of staff ☐
- Lack of staff and bed ☐
- Lack of equipment ☐

(*indicate in text box*) → END

Location of critical care:

- Critical care unit (H1N1 only) ☐ → **Type of unit:**
  - Adult, general ☐
  - Adult, surgical ☐
  - Adult, medical ☐
  - Paediatric ☐
  - Neurosciences ☐
  - Cardiac ☐
  - Thoracic ☐
  - Burns/plastic ☐
  - Spinal ☐
  - Renal ☐
  - Liver ☐
  - Obstetric ☐

  → **Other identifiers:**
  CMP/SICSAG/PICANet ID: ☐☐☐☐☐☐☐☐
  GAinS Study number: ☐☐☐
- Extended critical care area ☐
- Non-critical care area ☐

Suspected/confirmed H1N1 → **To**: Daily assessment

Non-H1N1 → **Date/Time/Status critical care ended** (*non-H1N1*)

Date: / /

Time: : 24hr

Status: Alive ☐ Dead ☐ → END

Text .....

.....

.....

Health Technology Assessment 2010; Vol. 14: No. 55, 335–492

Daily critical care assessment

NHS number (*or equivalent*): | | | | | | | | | | |

Hospital number: | | | | | | | | | | | | | | | | | | | |

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Date of daily assessment: / /

Daily critical care assessment (00:00-23:59)

Organ support *(tick all that apply)*:
- Advanced respiratory (Airway/Ventilation - paeds) ☐
- Advanced cardiovascular (Cardiovascular – paeds) ☐
- Renal ☐
- Hepatic ☐
- Neurological ☐

Antivirals *(tick all that apply)*:
- Oseltamivir (Tamiflu®) ☐
- Zanamivir (Relenza®) inhaled/nebulised ☐
- Zanamivir (Relenza®) intravenous ☐
- Ribavirin ☐
- Peramivir ☐

Other drugs *(tick all that apply)*:
- **Antimicrobials** ☐
- **Corticosteroids** ☐
- **rhAPC (Xigris®)** ☐
- **Dobutamine**
  - Any dose ☐
- **Dopamine** *highest dose - μg kg^{-1} min^{-1}*
  - ≤5 ☐
  - >5 and ≤15 ☐
  - >15 ☐
- **Epinephrine** *highest dose - μg kg^{-1} min^{-1}*
  - ≤0.1 ☐
  - >0.1 ☐
- **Norepinephrine** *highest dose - μg kg^{-1} min^{-1}*
  - ≤0.1 ☐
  - >0.1 ☐

Ventilation *(Advanced respiratory support only)*:
Prone positioning ☐ ECMO ☐ Surfactant ☐
Oscillation ☐ Nitric oxide ☐

Physiology — **Not assessed:**

Lowest PaO_2: | | | . | | kPa ☐ mmHg ☐ — ☐

Associated FiO_2: | | | % — ☐

Lowest blood pressure *(lowest systolic/paired diastolic)*: | | | / | | | mmHg — ☐

Highest heart rate: | | | beats min^{-1} — ☐

Highest central venous pressure : | | mmHg — ☐

Lowest total Glasgow Coma Score: | | — ☐

Highest total serum bilirubin: | | | | . | | μmol l^{-1} — ☐

Lowest platelet count: | | | | x10^9 l^{-1} — ☐

Highest blood lactate: | | . | | mmol l^{-1} — ☐

Highest serum creatinine: | | | | μmol l^{-1} — ☐

Total urine output: 24hr ☐ | | | | | ml Or over | | hrs — ☐

Overall fluid balance: 24hr ☐
+ ☐ / - ☐ | | | | | ml Or over | | hrs — ☐

By 23:59

H1N1 status: Suspected ☐ Confirmed ☐ Confirmed - now suspected/tested negative) ☐ Suspected - now tested negative ☐

Active treatment withdrawn: Yes ☐ No ☐

Main reason active treatment withdrawn:
Futility ☐ Lack of staff and bed ☐
Lack of staff ☐ Lack of equipment ☐ *(indicate in text box)*

Date/Time/Status critical care ended
Date: / / **Time:** : 24hr
Status : Alive ☐ Dead ☐

END

Daily outcome:
Died while receiving critical care (your hospital) ☐
Critical care ended (your hospital) ☐
Critical care continuing (your hospital) ☐

Time of death: : 24hr

END

Time critical care ended: : 24hr

Critical care ended early: Yes ☐ No ☐

Main reason critical care ended early:
Futility ☐ Lack of staff and bed ☐
Lack of staff ☐ Lack of equipment ☐ *(indicate in text box)*

Location following critical care:
Non-critical care area (your hospital) ☐
Non-critical care area (other hospital) ☐
Not in hospital ☐
Critical care area (other hospital) ☐

END

Receiving hospital (*name*):

END

Critical care location (your hospital):
Critical care unit ☐
Extended critical care area ☐
Non-critical care area ☐

Type of unit:
Adult, general ☐
Adult, surgical ☐
Adult, medical ☐
Paediatric ☐
Neurosciences ☐
Cardiac ☐
Thoracic ☐
Burns/plastic ☐
Spinal ☐
Renal ☐
Liver ☐
Obstetric ☐

Other identifiers:
CMP/SICSAG/PICANet ID: | | | | | | | | | |
GAinS Study number: | | |

To: Next day assessment

Text .....

Appendix 3

SwiFT weekly report

Key messages from SwiFT (to week 52)

- Number of new cases continues to decline gradually
- H1N1 cases - confirmed (ever) 38%, suspected 18%, tested negative 44%
- H1N1 cases aged 25-64 years predominate
- 16% female confirmed H1N1 cases reported currently/recently pregnant
  6% female suspected H1N1 cases reported currently/recently pregnant
- 26% confirmed H1N1 cases reported obese/morbidly obese
  15% suspected H1N1 cases reported obese/morbidly obese
- 41% confirmed H1N1 cases reported no chronic organ dysfunction
  48% suspected H1N1 cases reported no chronic organ dysfunction
- 31/1083 (2.9%) H1N1 cases reported managed in extended critical care area
- 18% confirmed H1N1 died by end of critical care (19% cases not yet reported)
- Confirmed H1N1 median 9 days of critical care
- 77% confirmed H1N1 cases reported to receive advanced respiratory support for median 9 days
- 21% confirmed H1N1 cases reported to receive renal support
- Risk factors for mortality among confirmed H1N1 cases: increasing age (and possible increased risk at youngest age); severe chronic organ dysfunction; presentation with exacerbation of airflow limitation associated with decreased risk
- Factors associated with increased duration of critical care among confirmed H1N1 cases: middle age (decreased duration at younger and older ages relative to age 45); overweight; confirmed H1N1 on initial assessment; receipt of antivirals on initial assessment; presentation with viral pneumonitis/ ARDS; moderate or severe chronic organ dysfunction; confusion; raised urea

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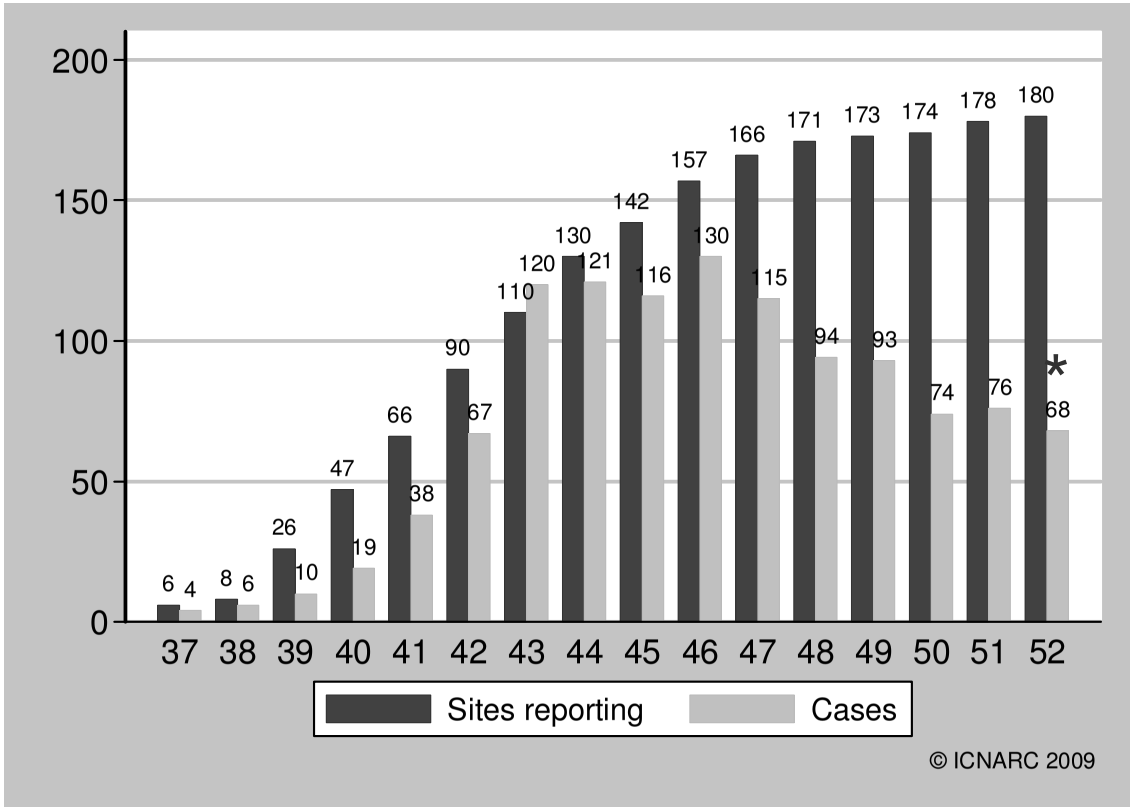
SwiFT data collection (all sites)



* Week 52 – not complete

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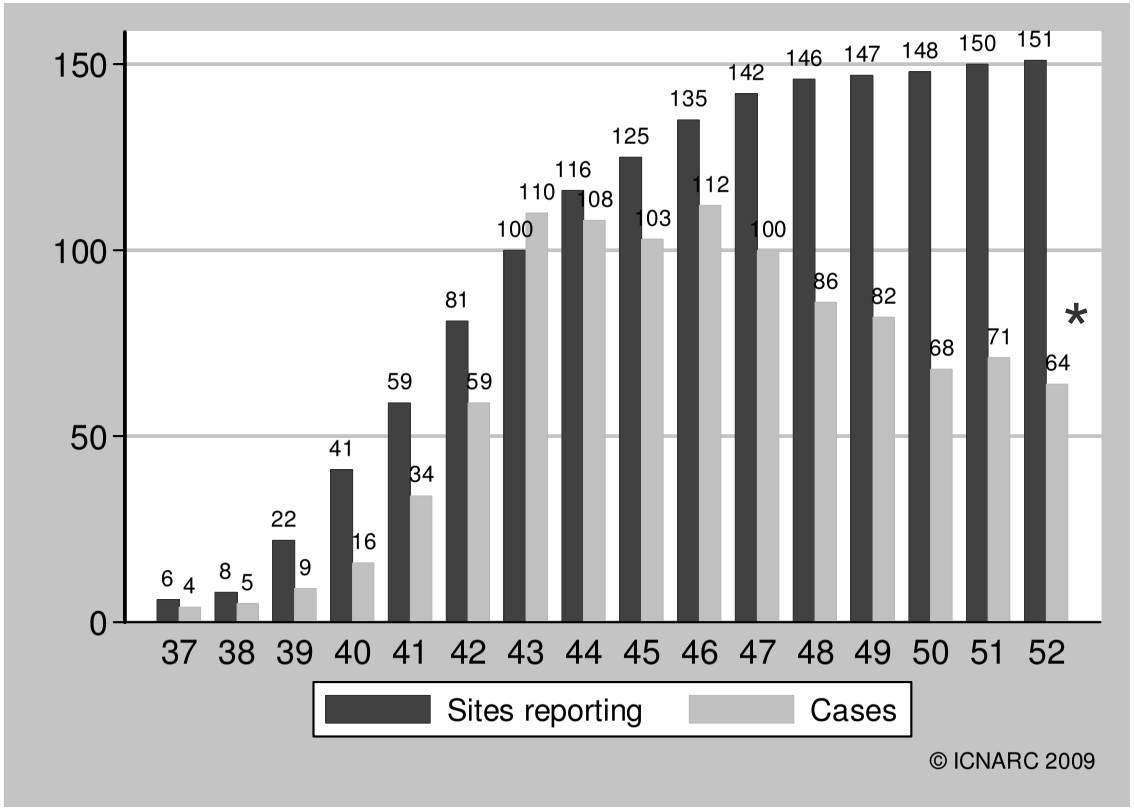
SwiFT data collection (England)



* Week 52 - not complete

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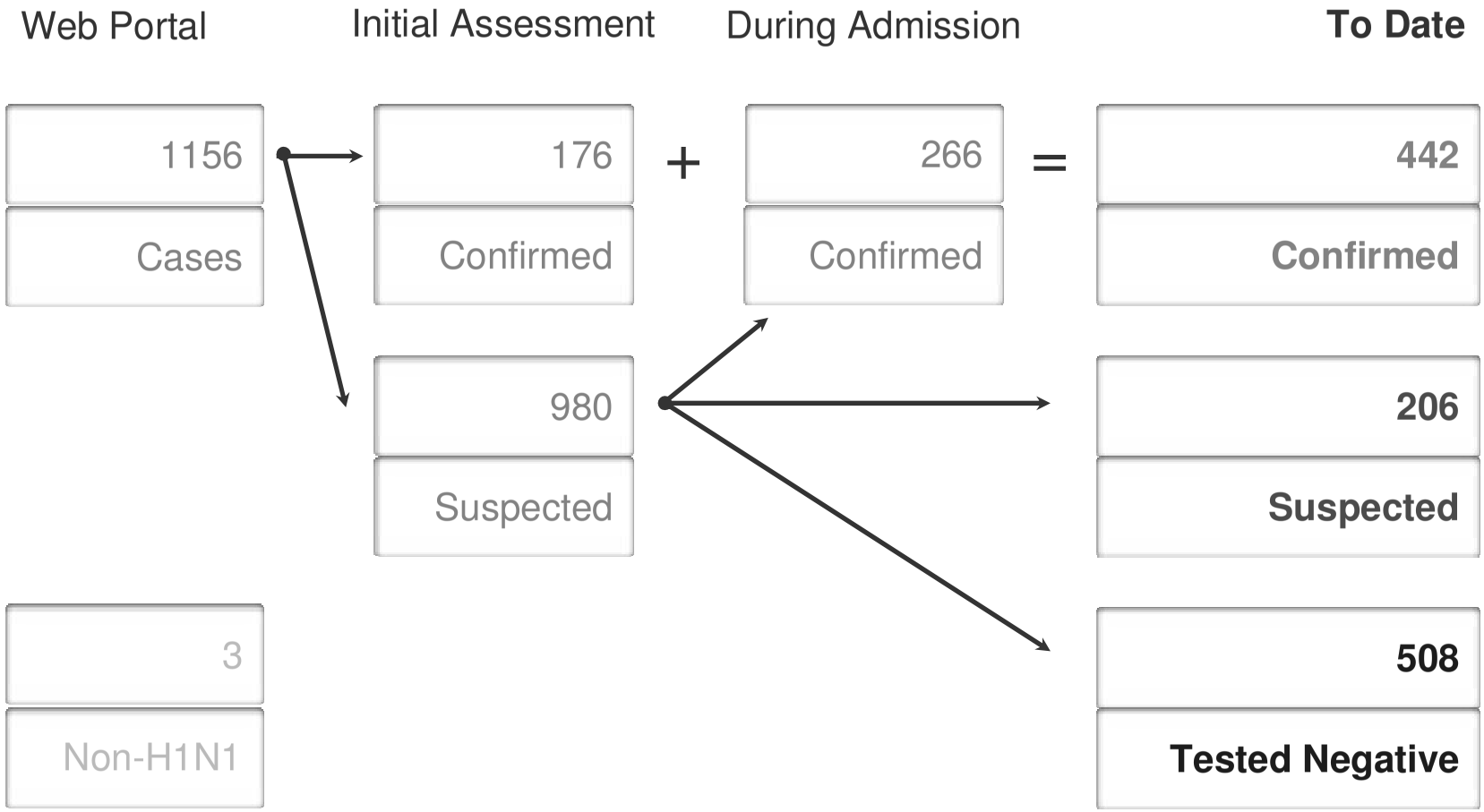
SwiFT H1N1 Case Flow



Week 52

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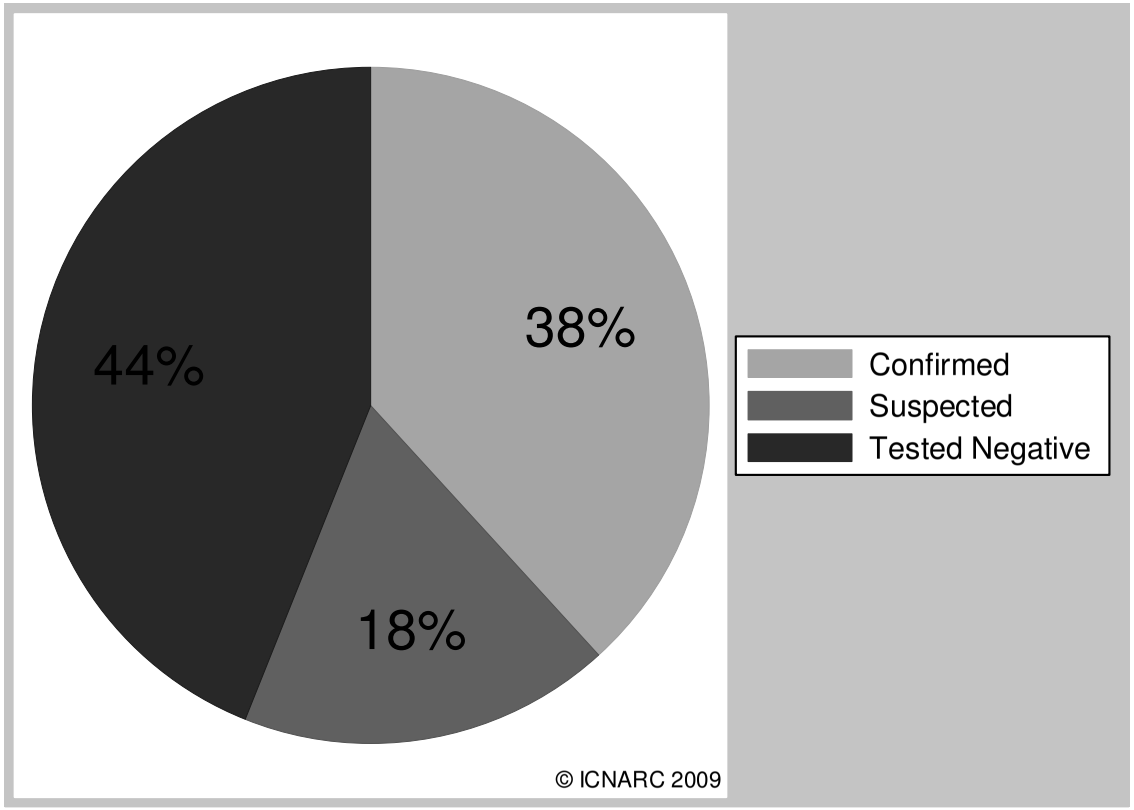
H1N1 status



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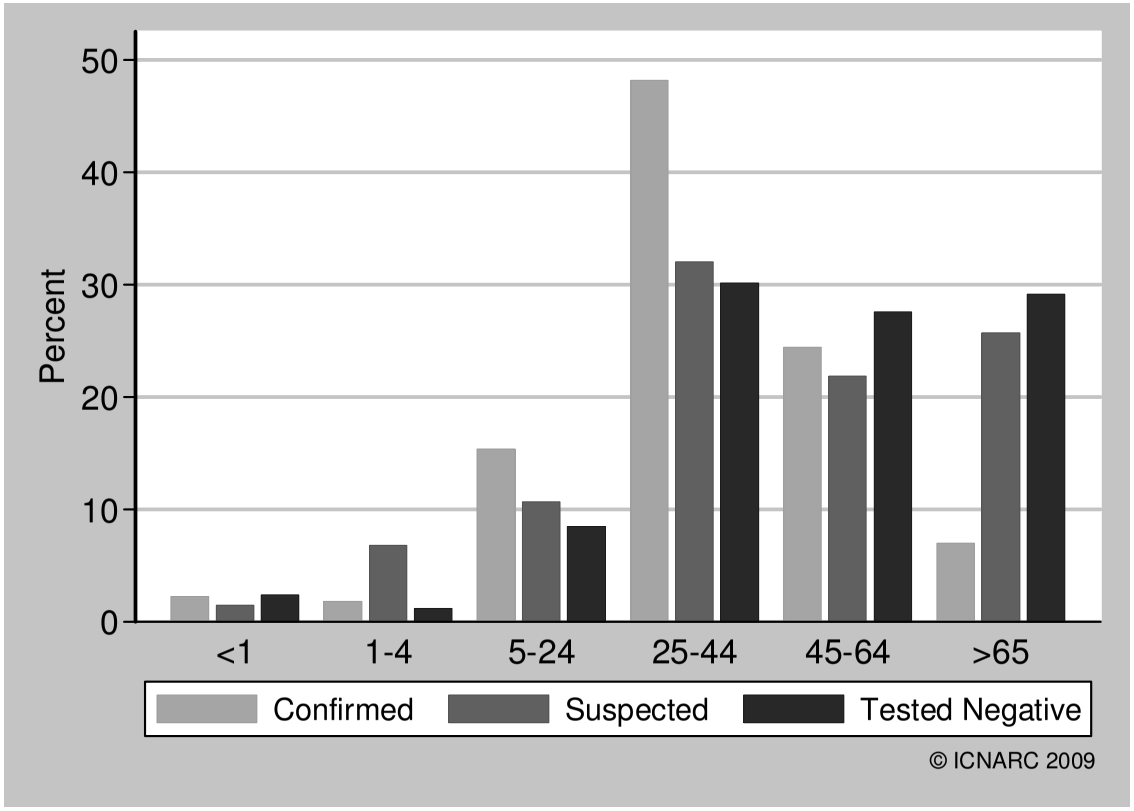
Age distribution (years) by H1N1 Status



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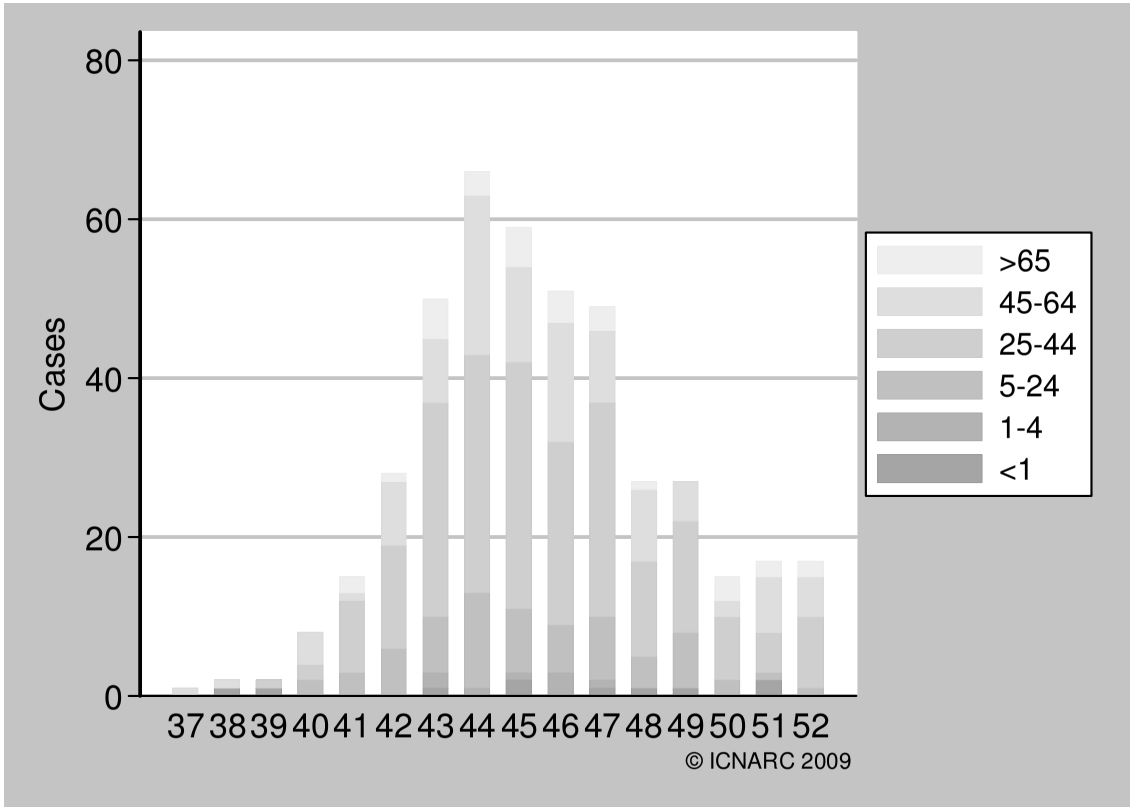
Confirmed H1N1 age group



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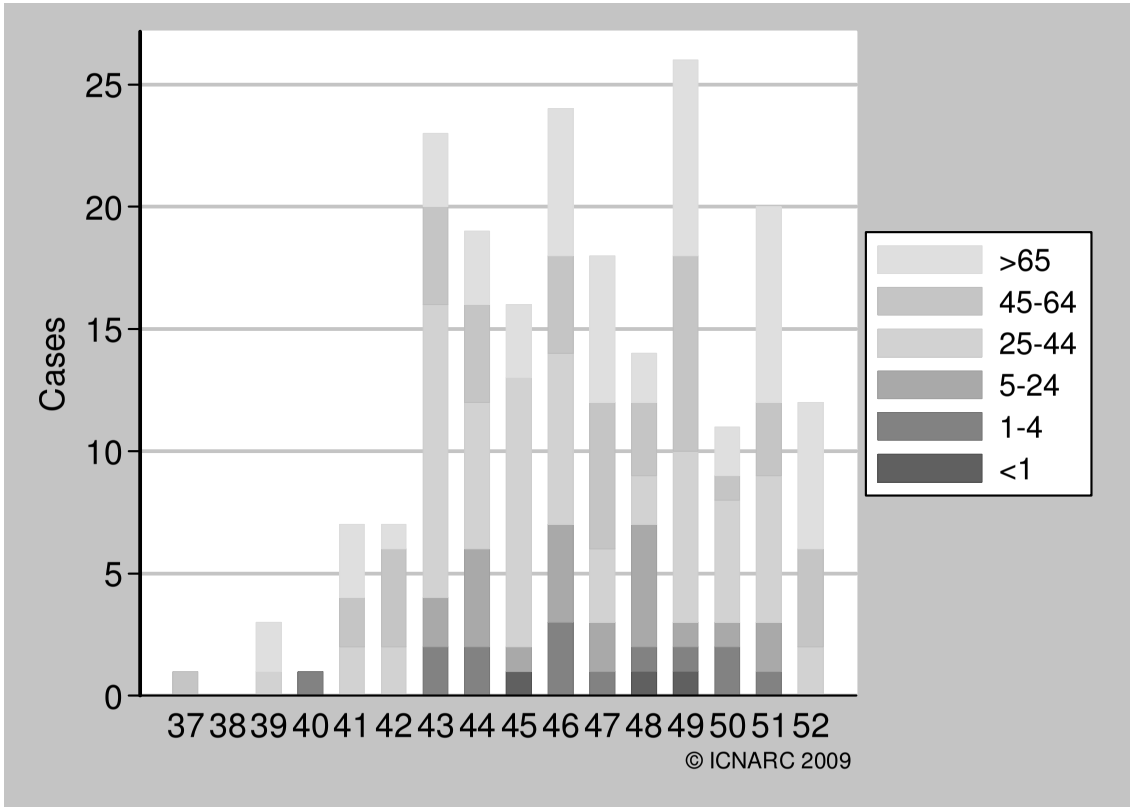
Suspected H1N1 age group



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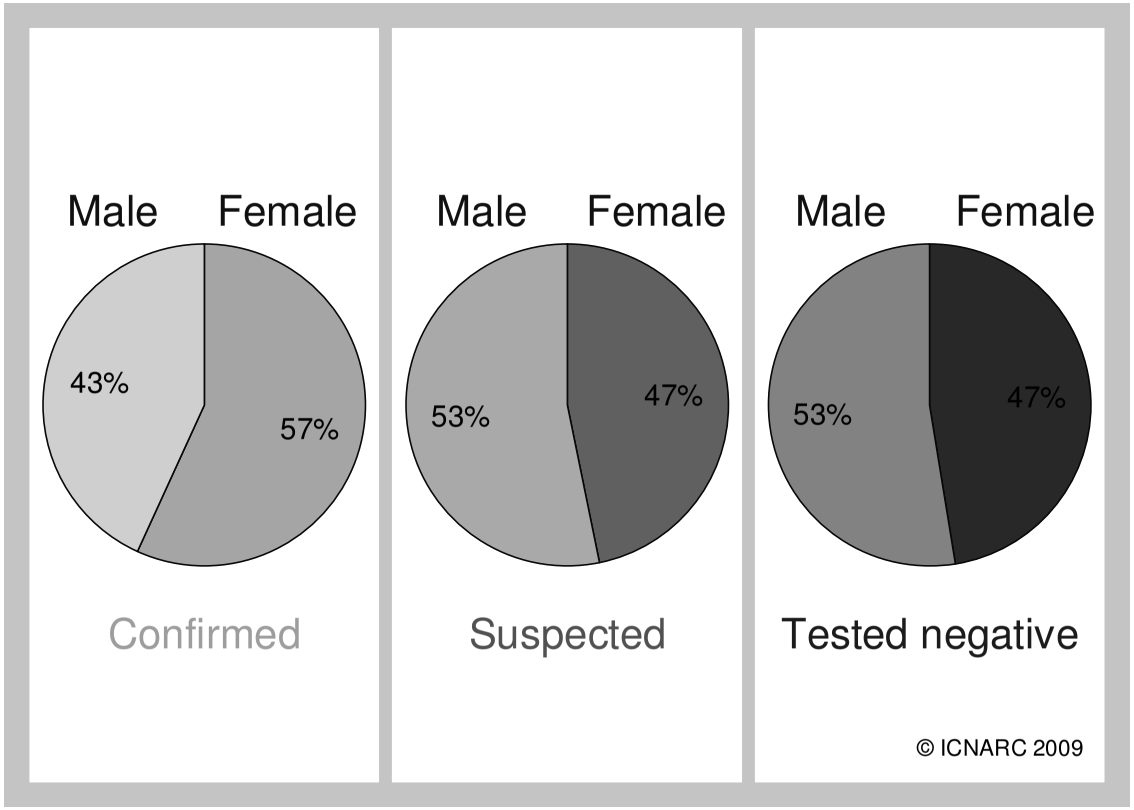
Male / Female by H1N1 status



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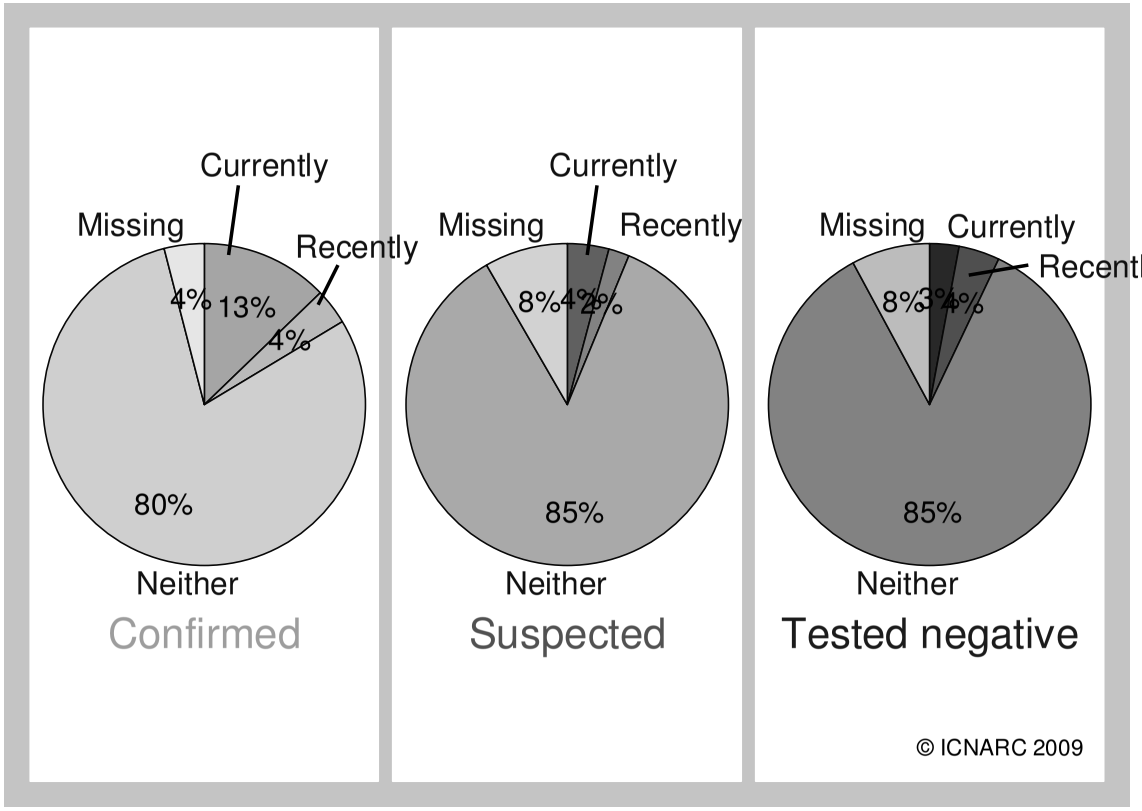
Pregnancy by H1N1 status



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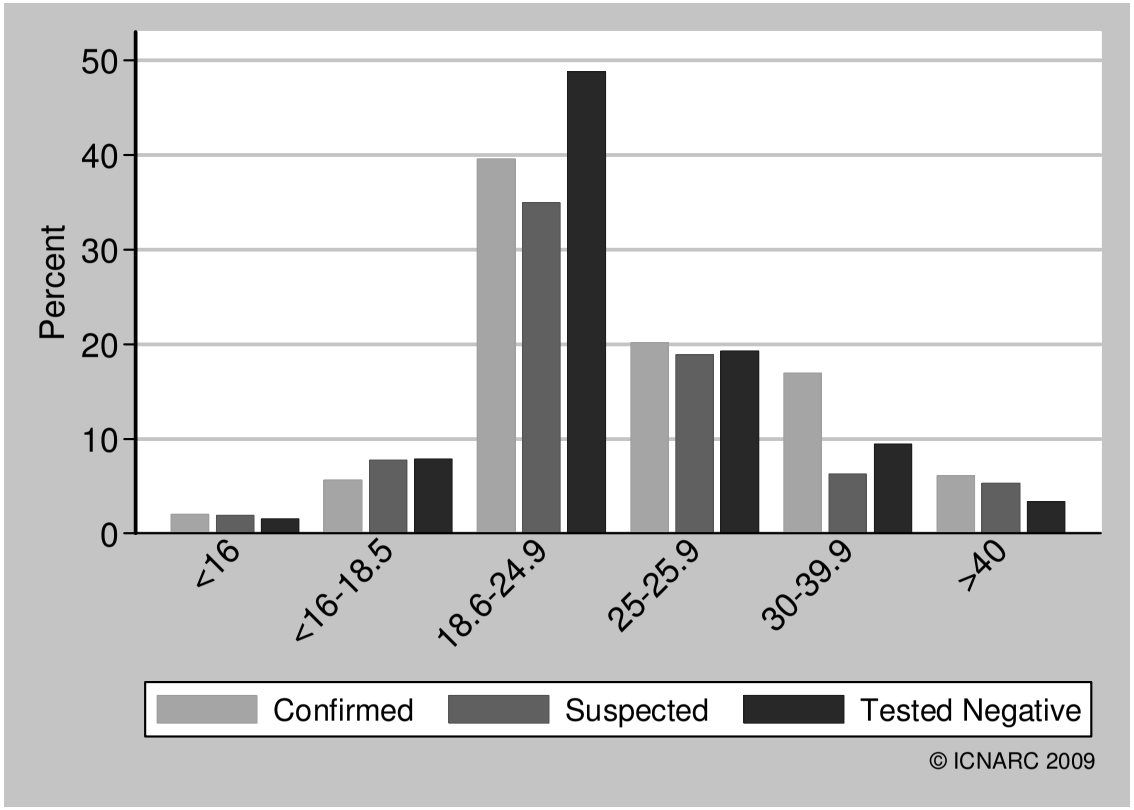
Reported body composition (BMI) by H1N1 Status



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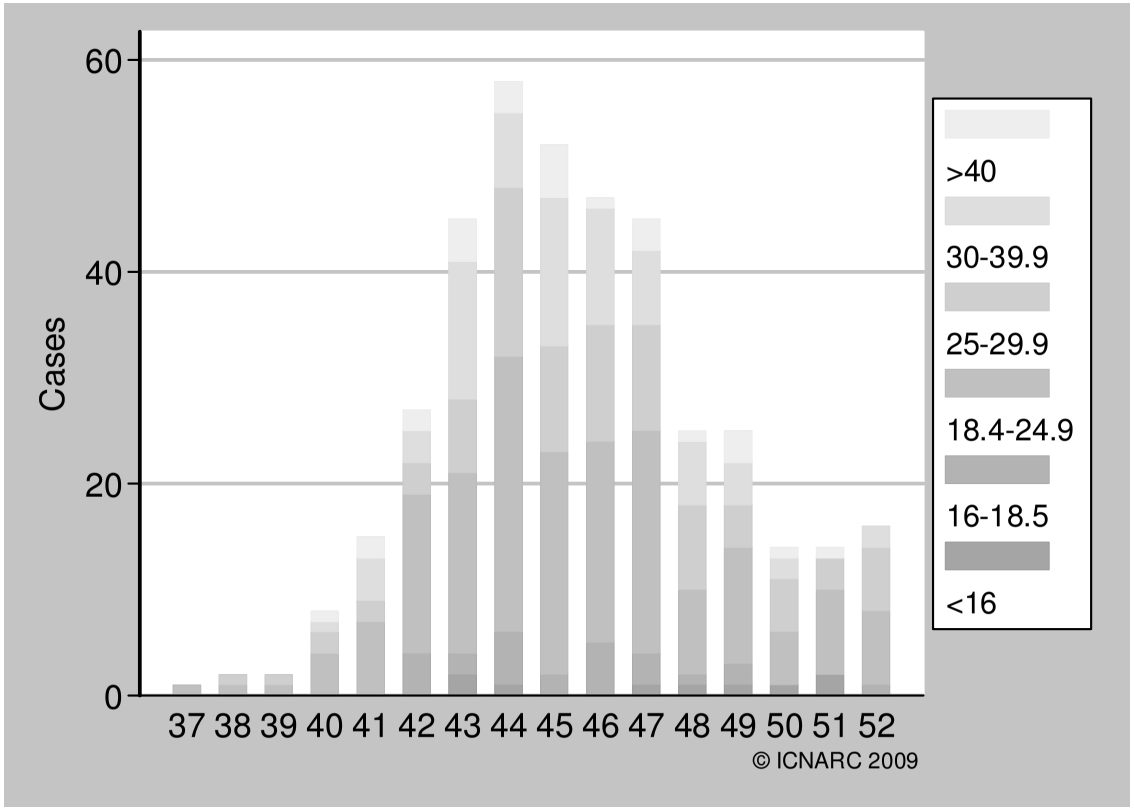
Confirmed H1N1 body composition (BMI)



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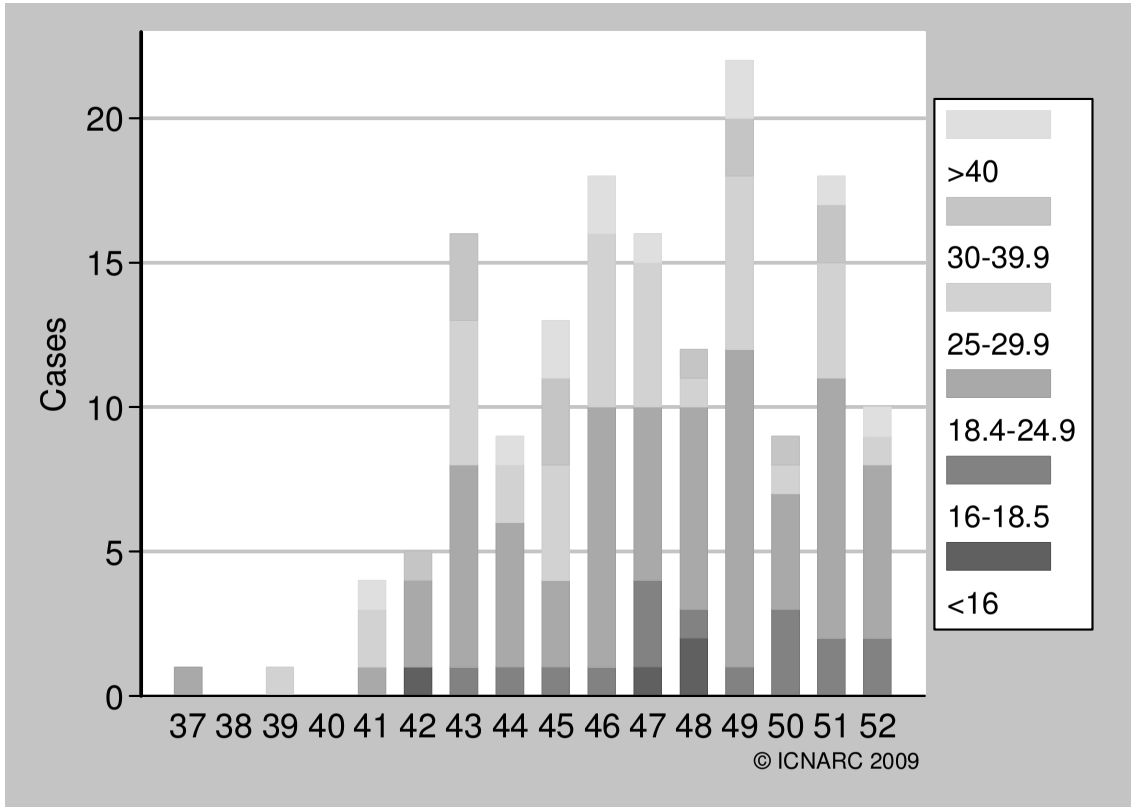
Suspected H1N1 body composition (BMI)



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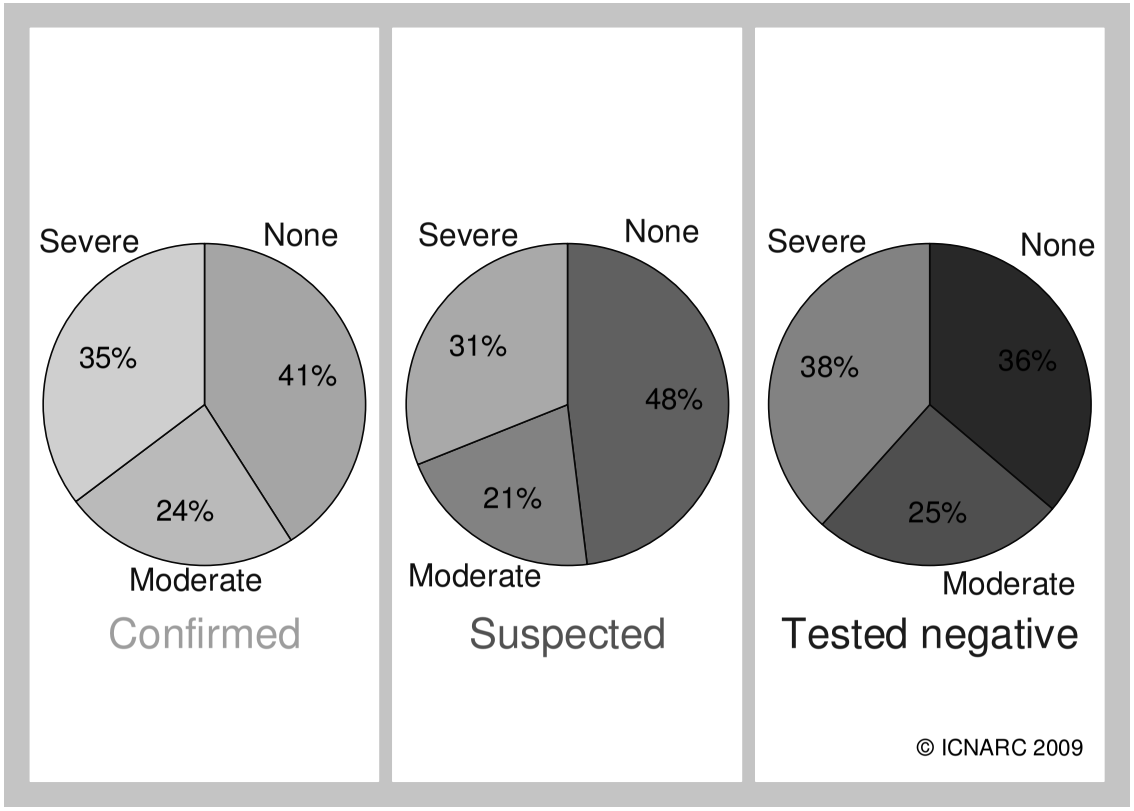
Reported chronic organ dysfunction by H1N1 status



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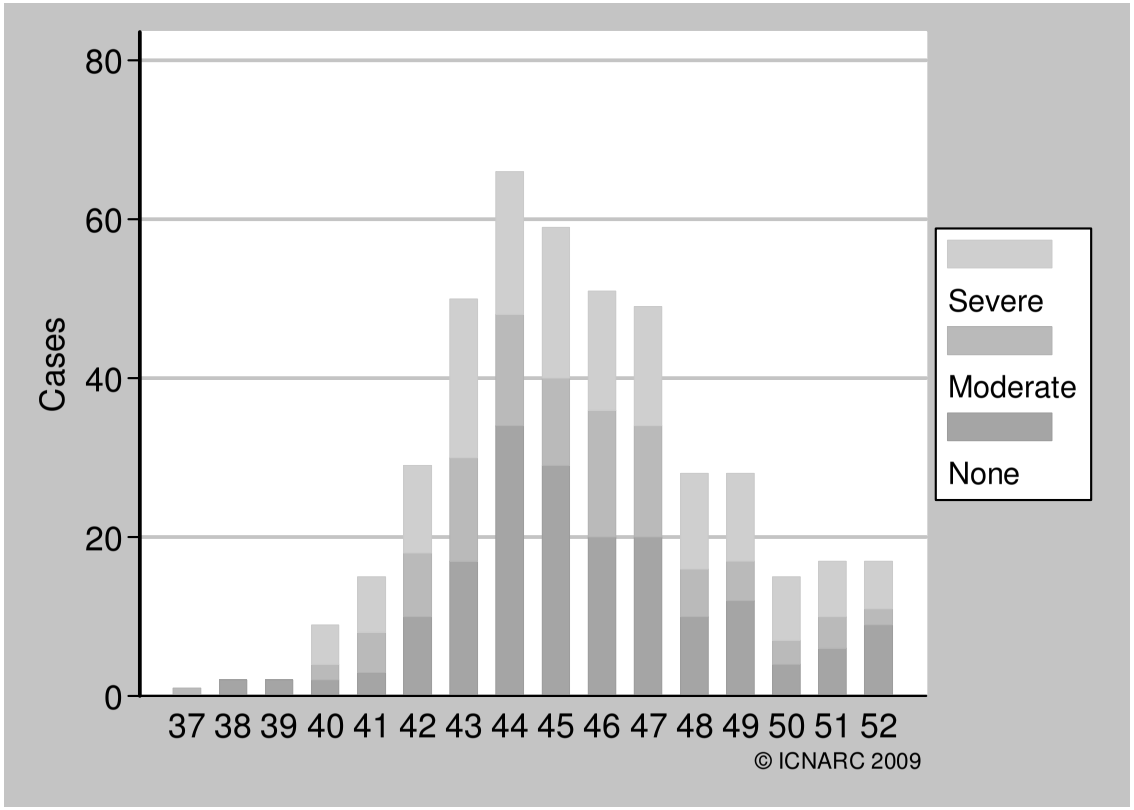
Confirmed H1N1 chronic organ dysfunction



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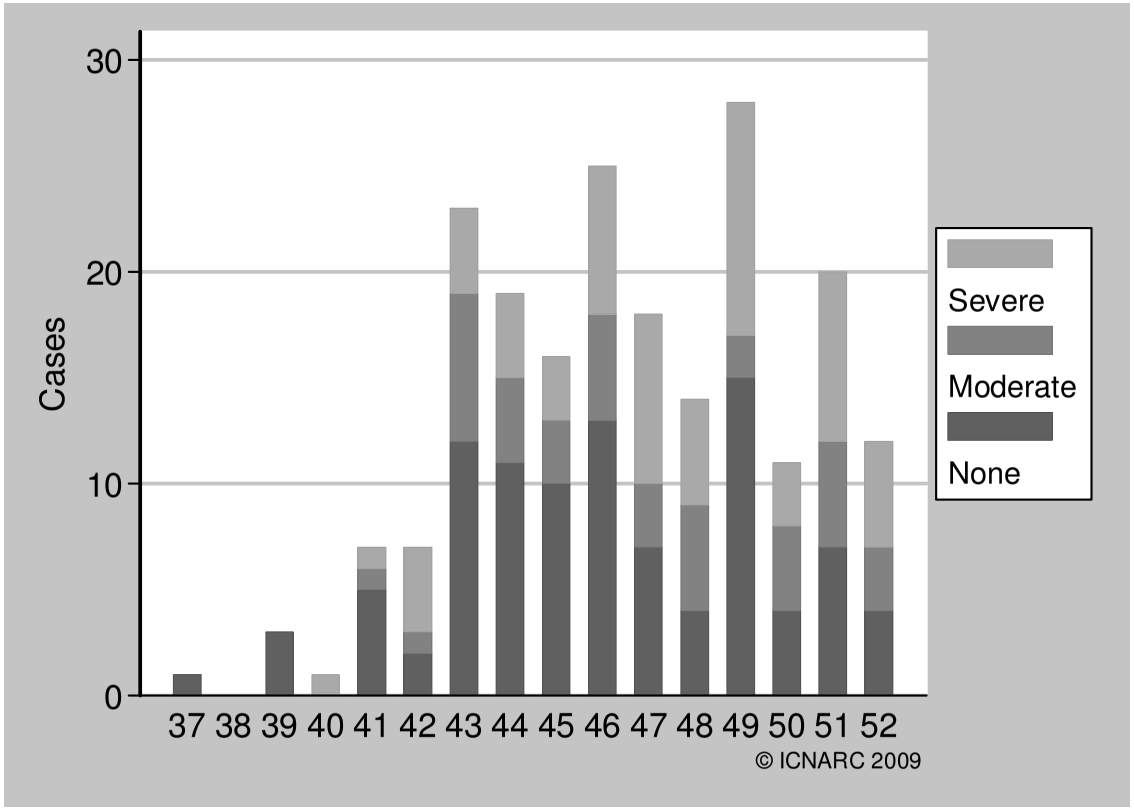
Suspected H1N1 chronic organ dysfunction



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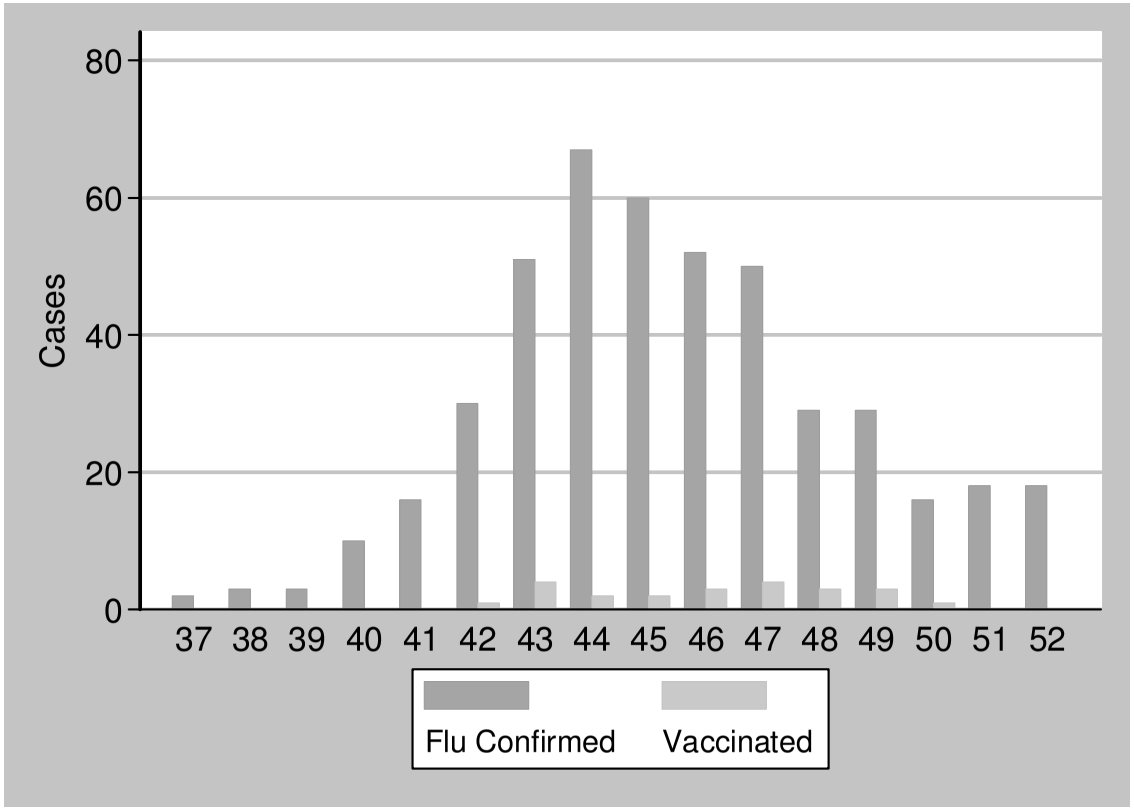
Confirmed H1N1 vaccination status



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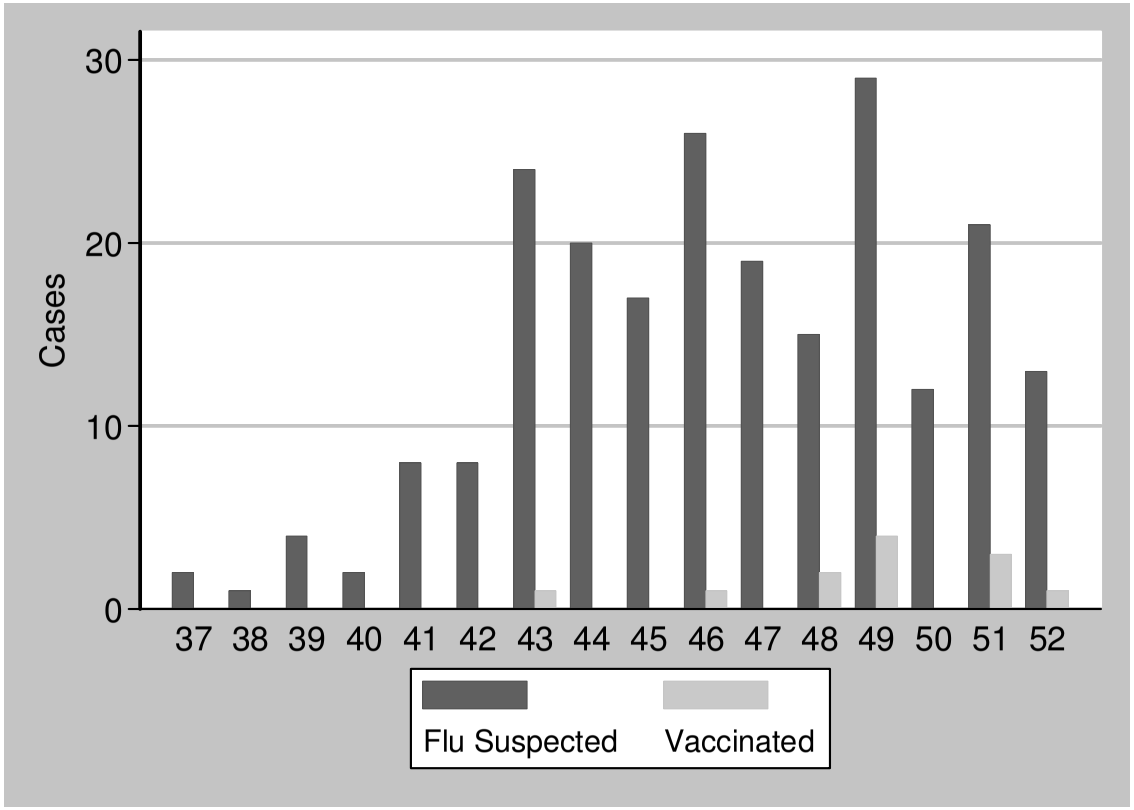

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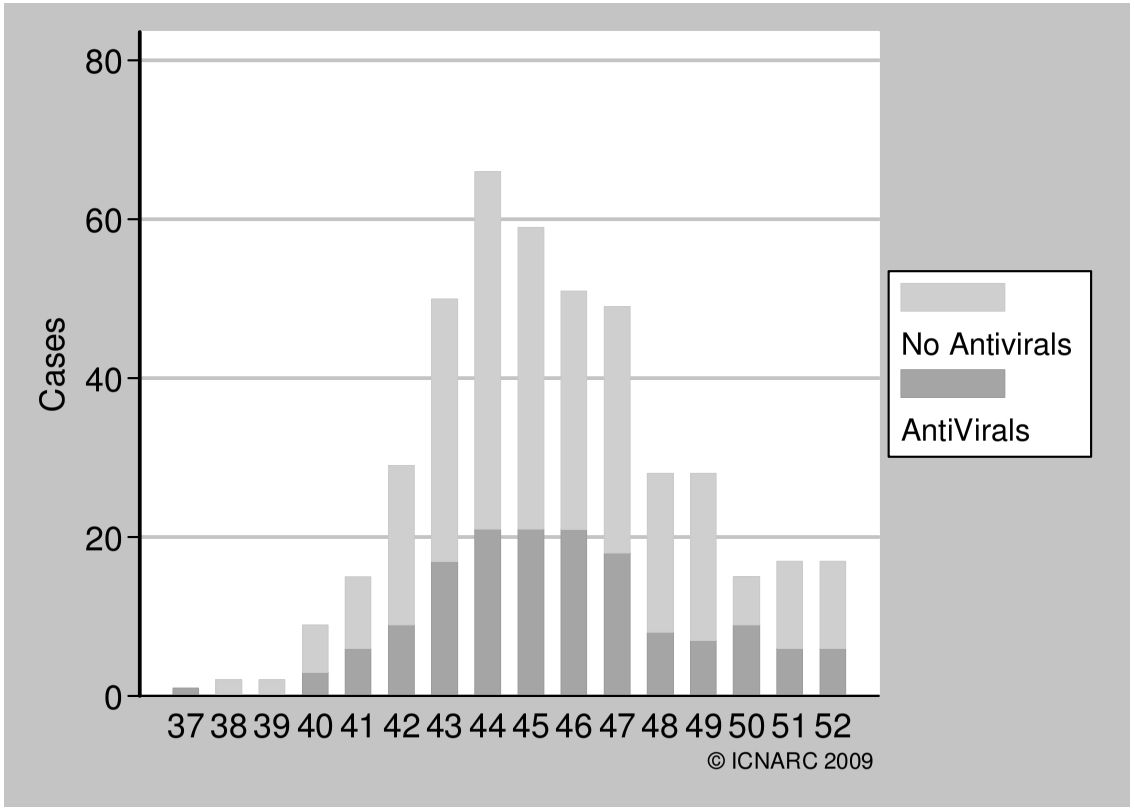
Confirmed H1N1 antivirals on assessment



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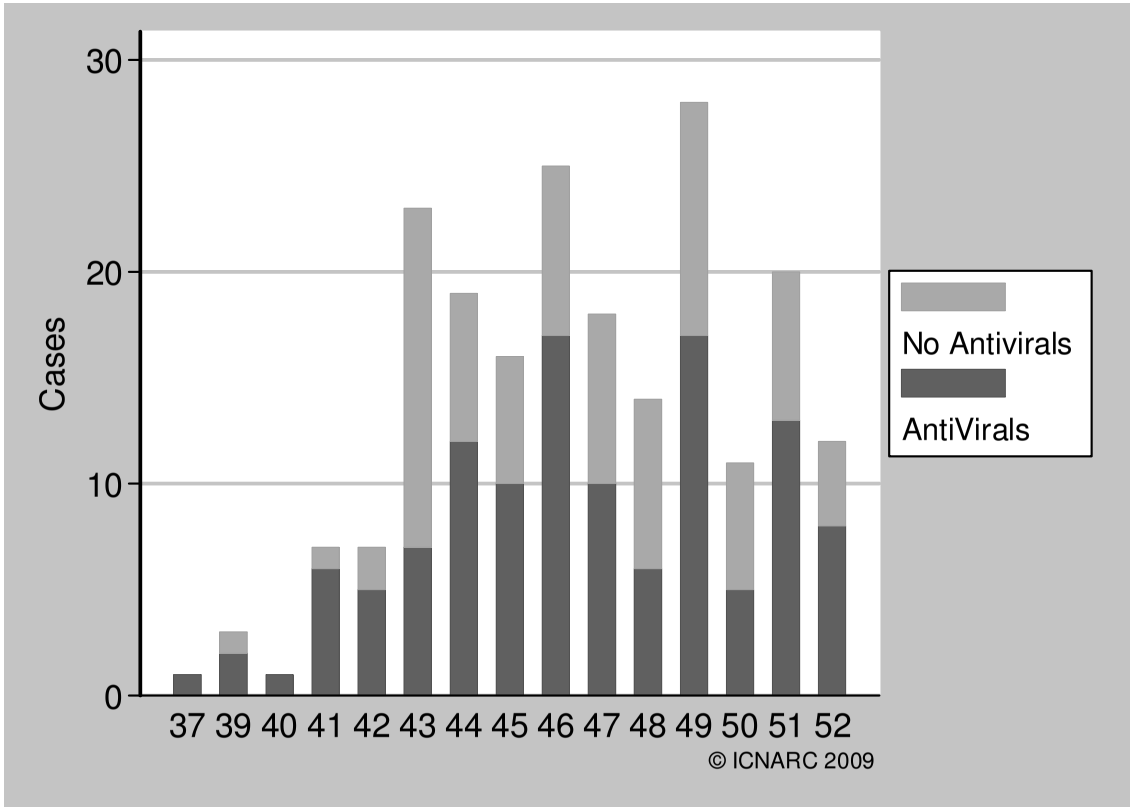
Suspected H1N1 antivirals on assessment



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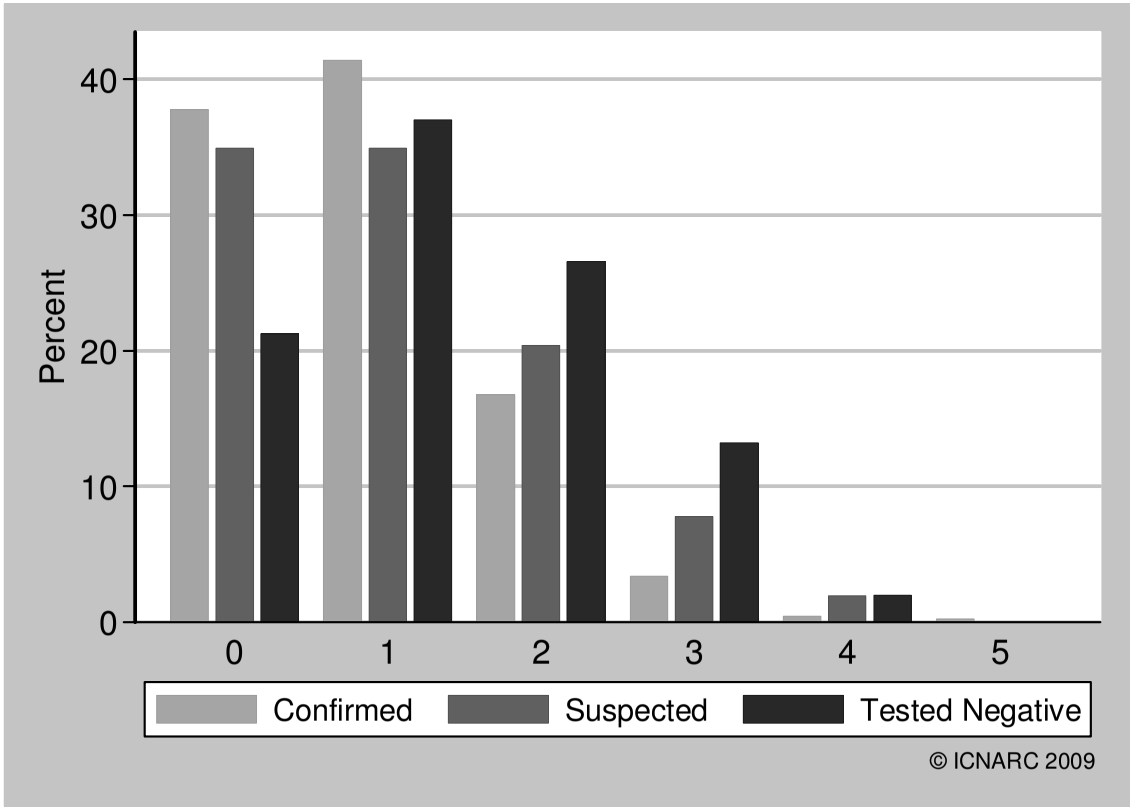
CURB-65 (severity of illness) by H1N1 status



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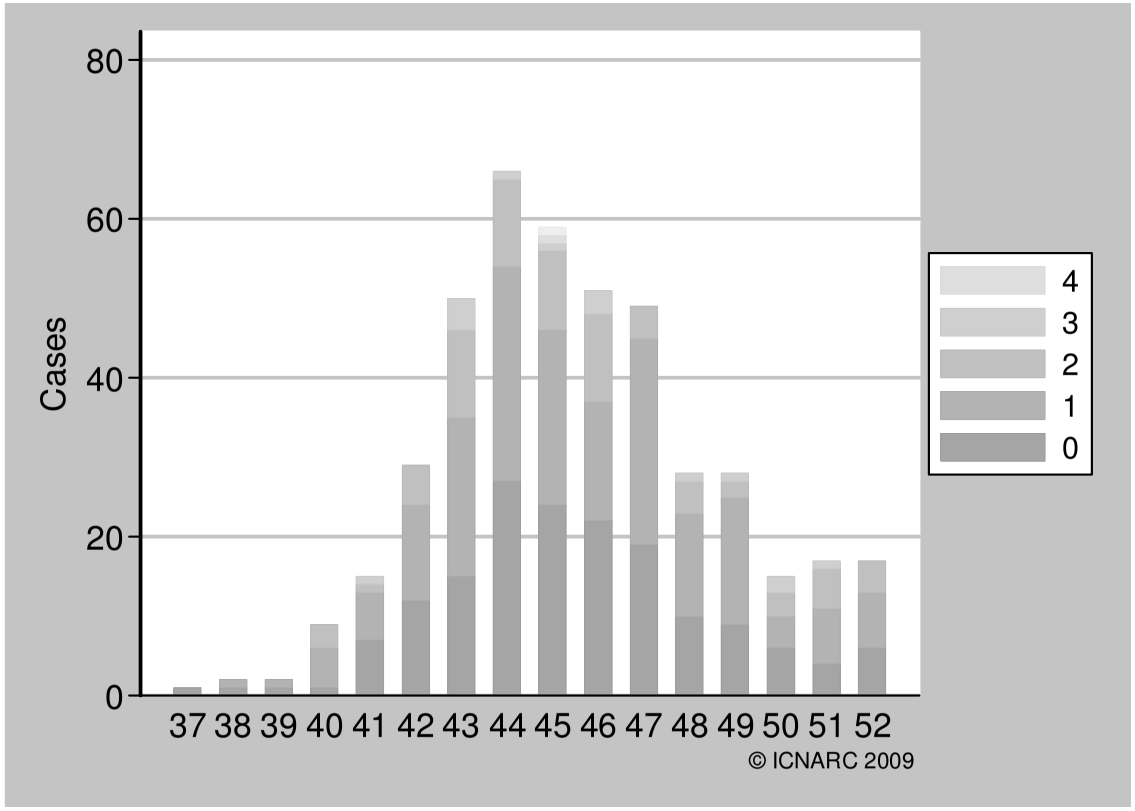
Confirmed H1N1 severity of illness (CURB-65)



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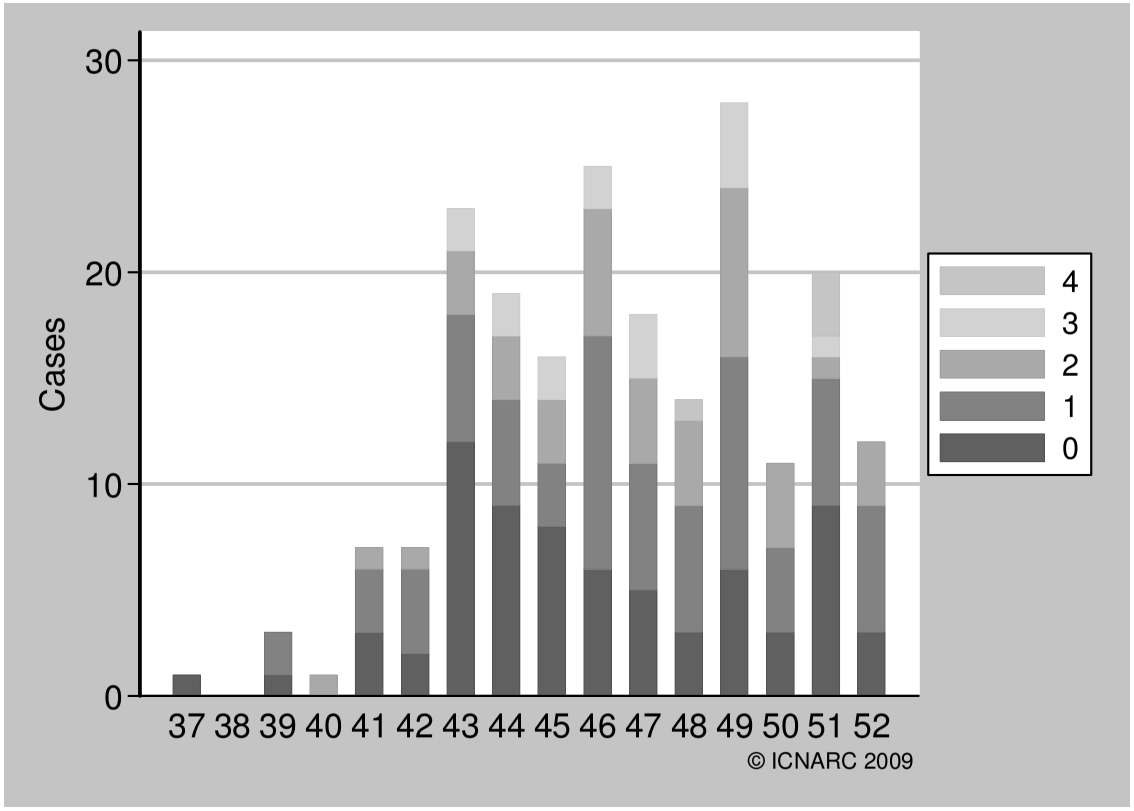
Suspected H1N1 severity of illness (CURB-65)



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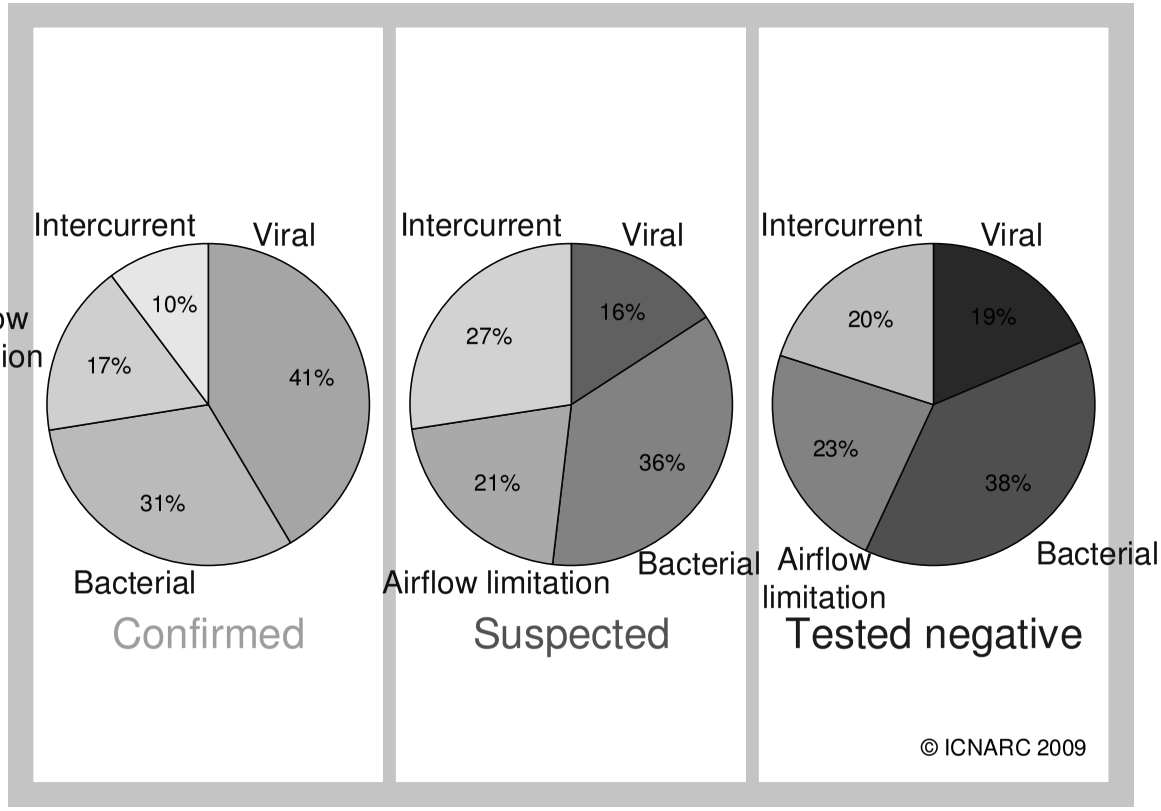
Reported presentation by H1N1 status



* Viral pneumonitis/ARDS; Secondary bacterial pneumonia; Exacerbation of airflow limitation; Other intercurrent illness

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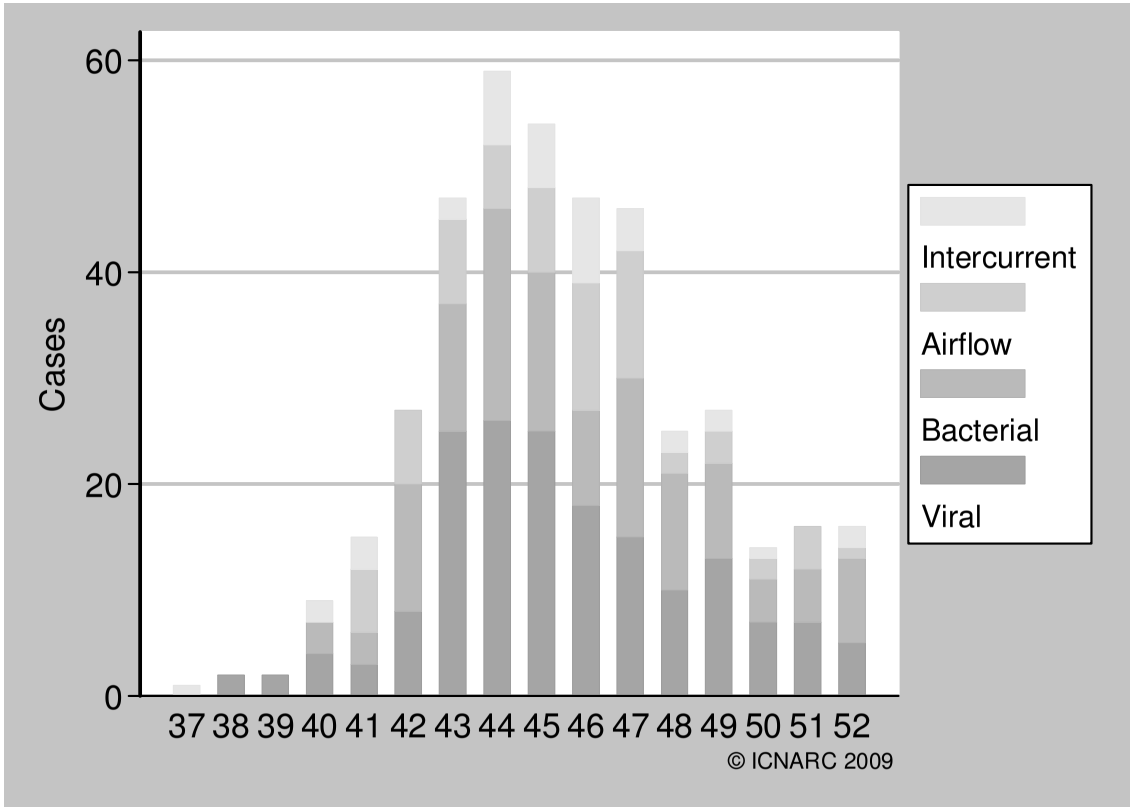
Confirmed H1N1 presentation



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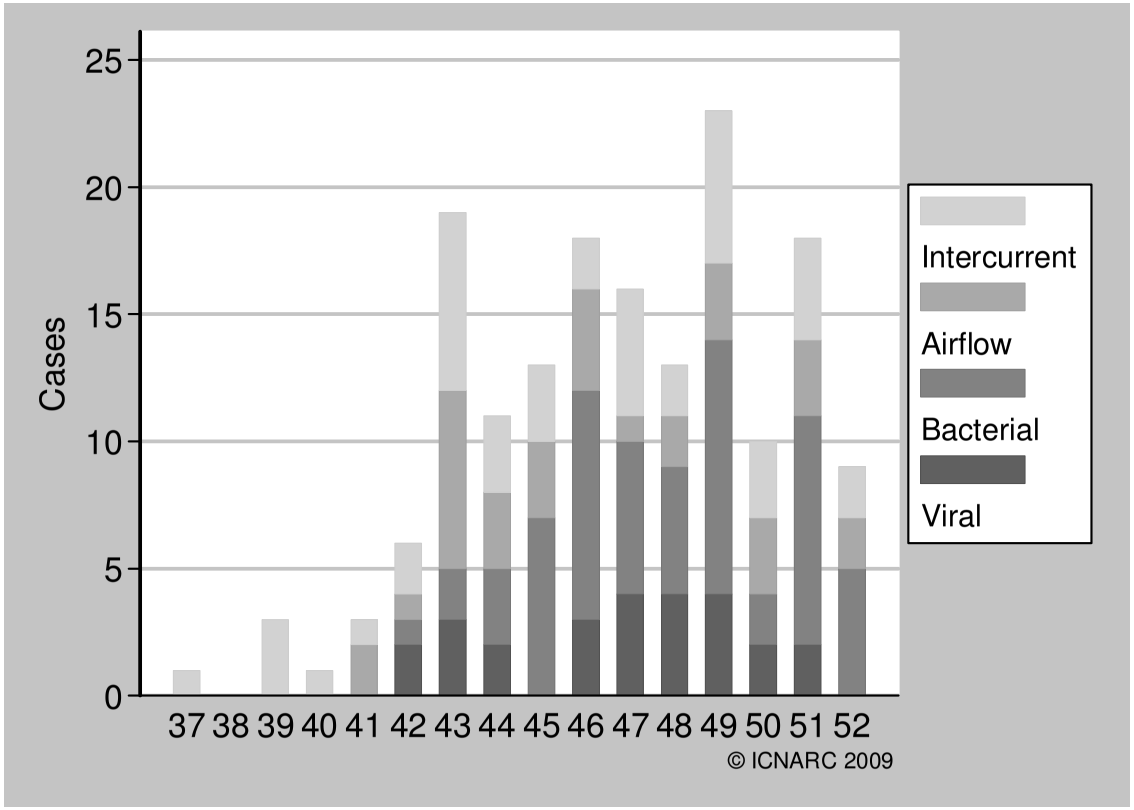
Suspected H1N1 presentation



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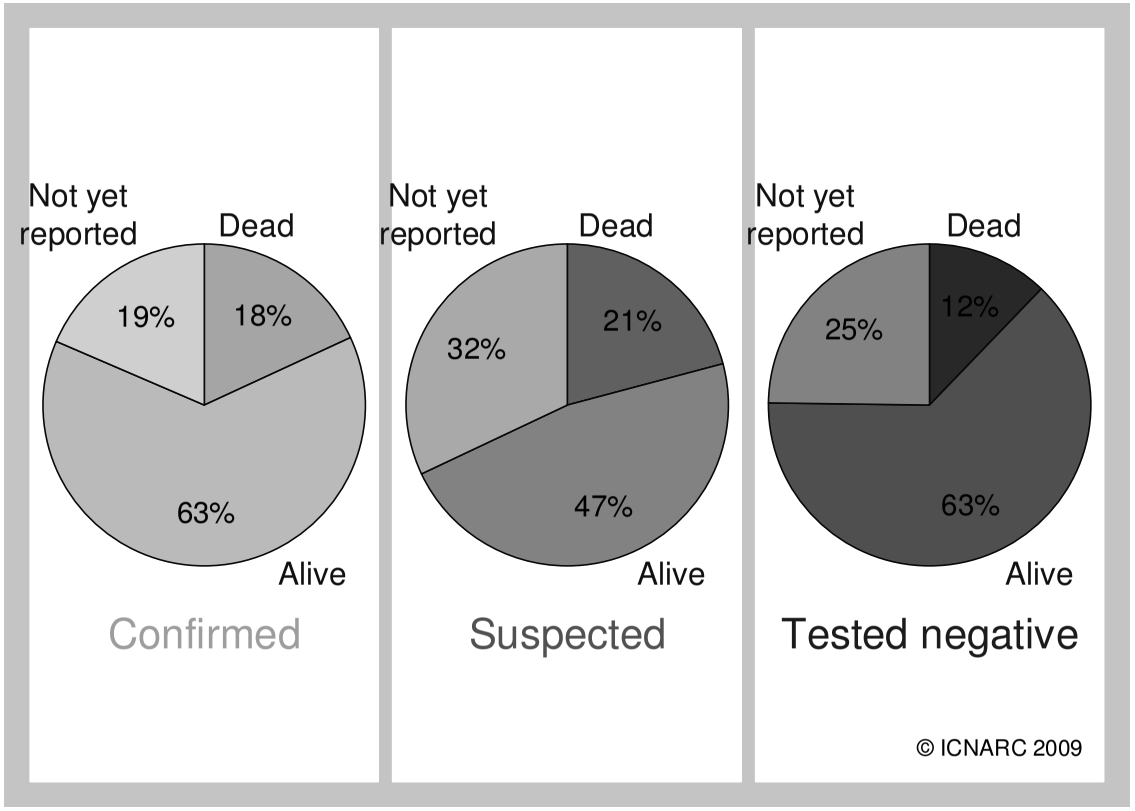
Survival status at end of critical care by H1N1 status



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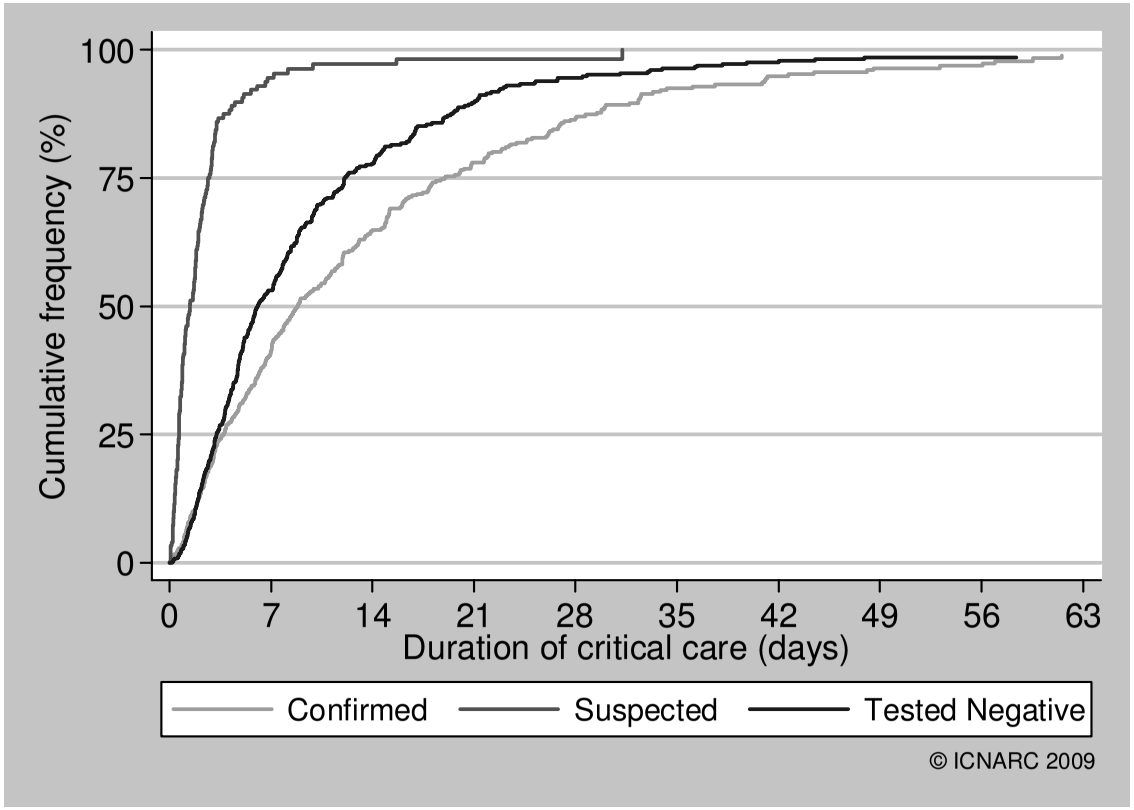
Duration of critical care



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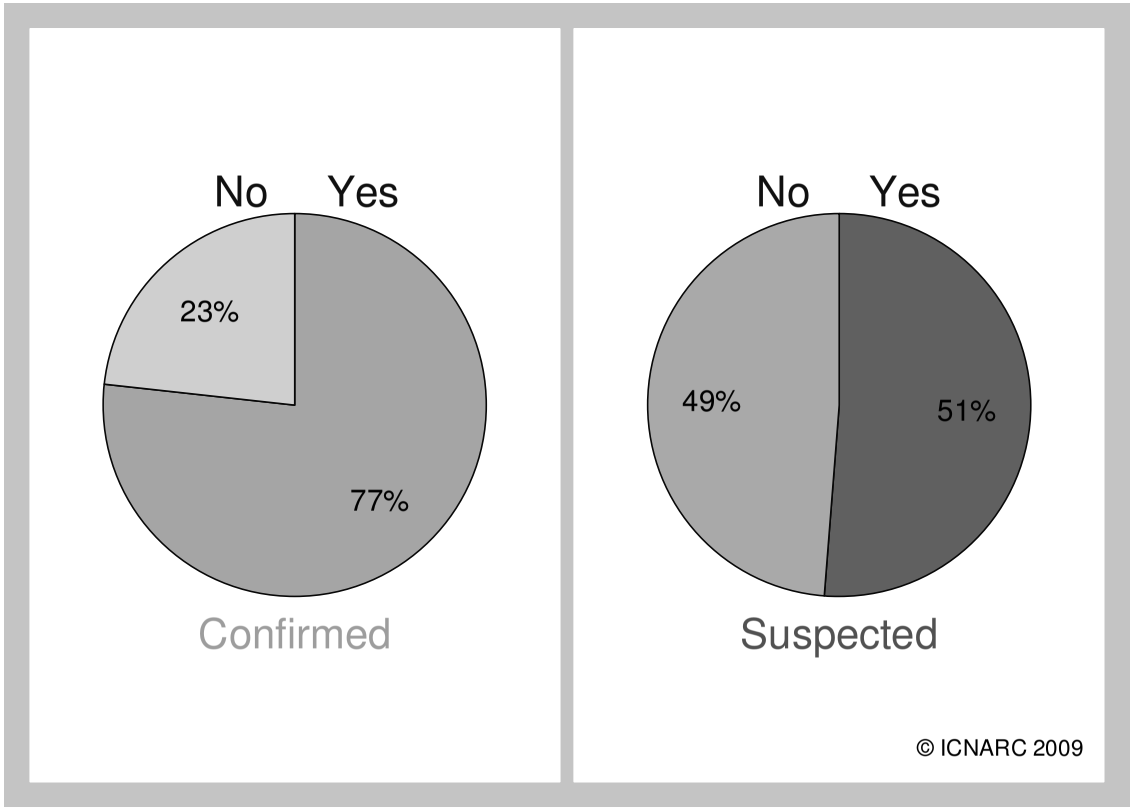
Organ support received at any time – advanced respiratory



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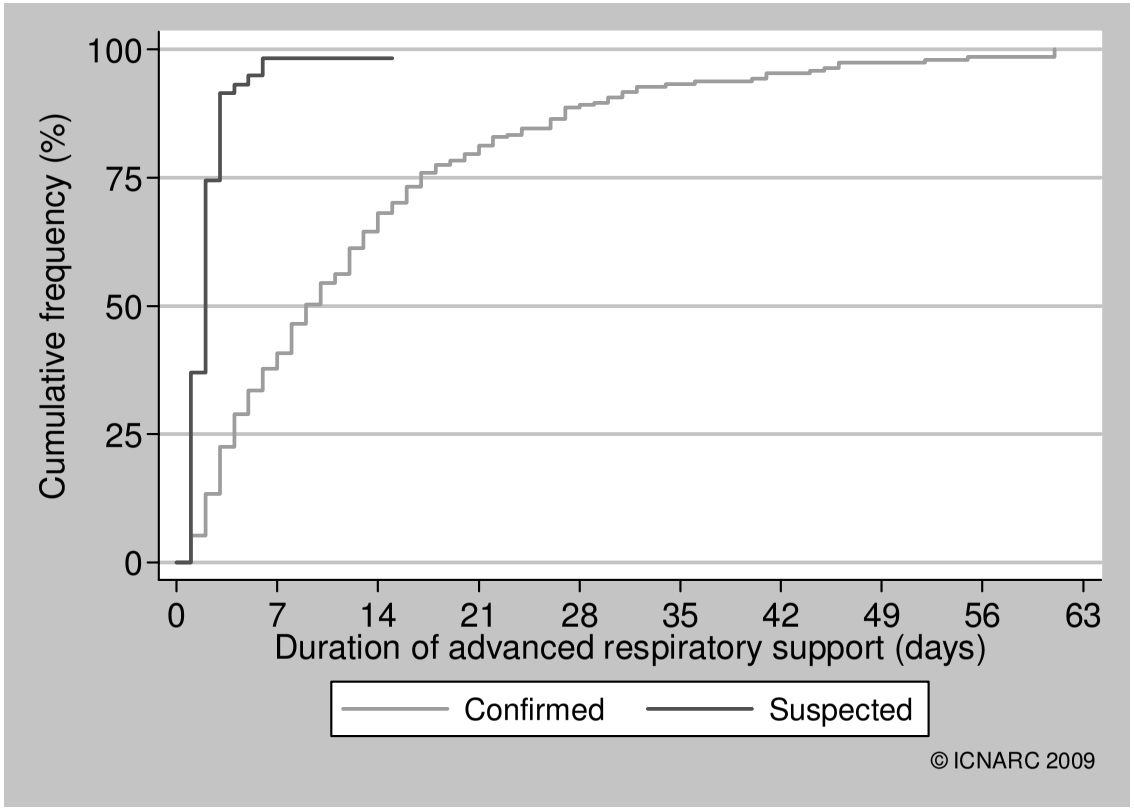
Duration of advanced respiratory support



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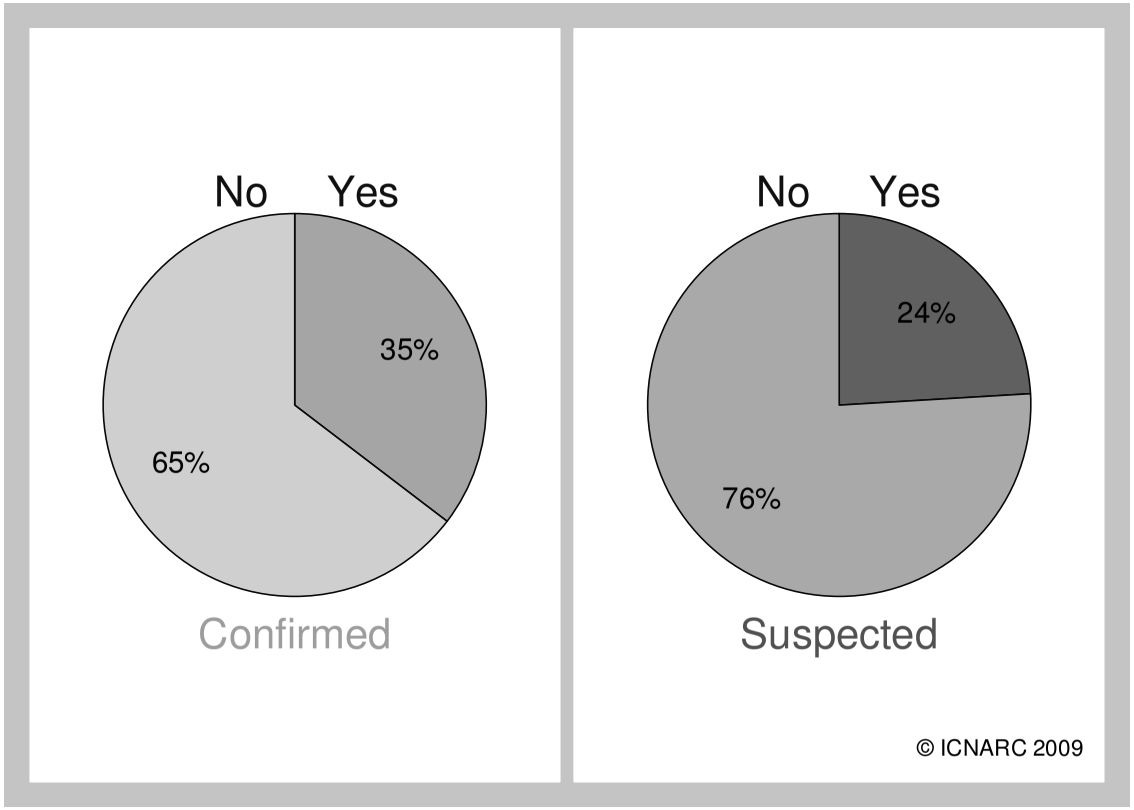
Organ support received at any time – advanced cardiovascular



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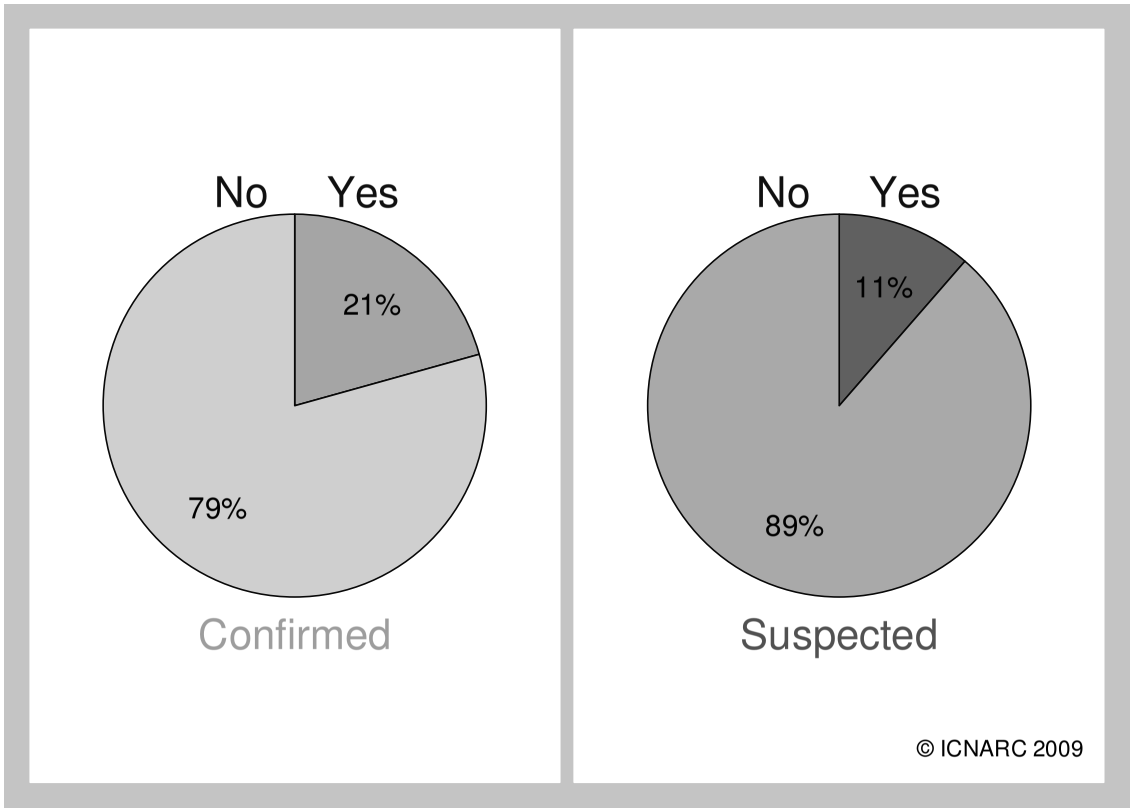
Organ support received at any time – renal



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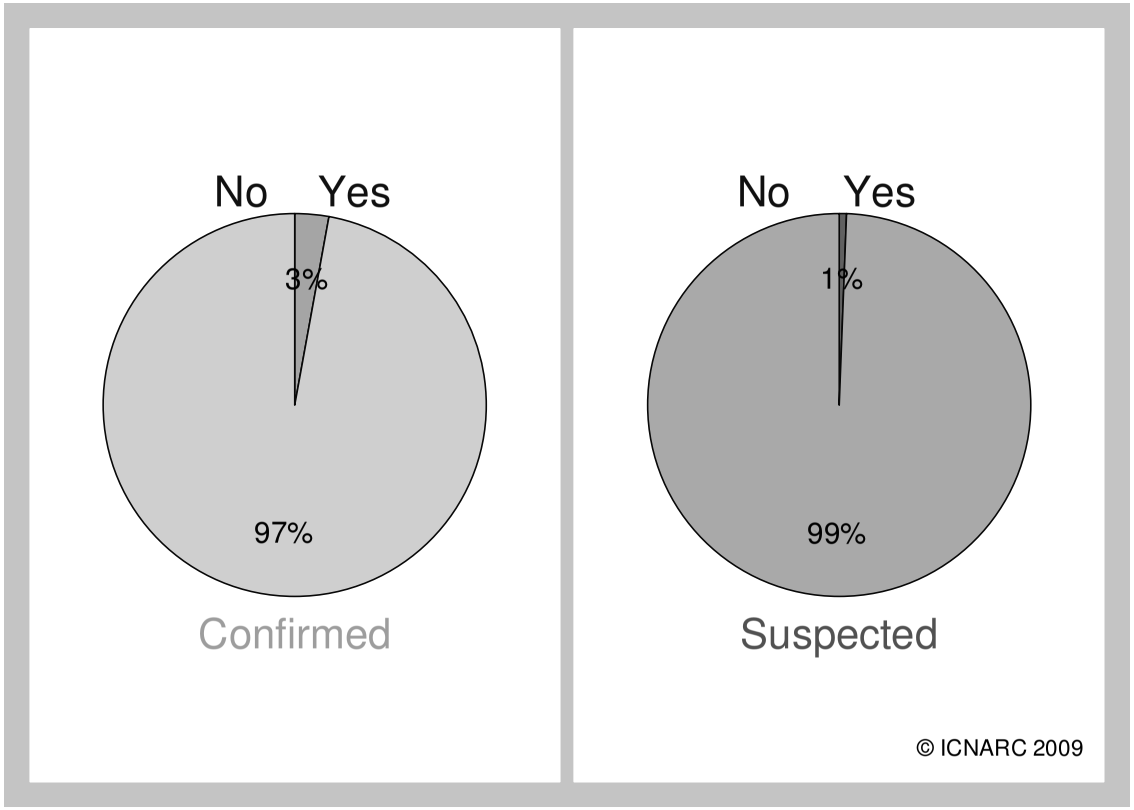
Organ support received at any time – neurological



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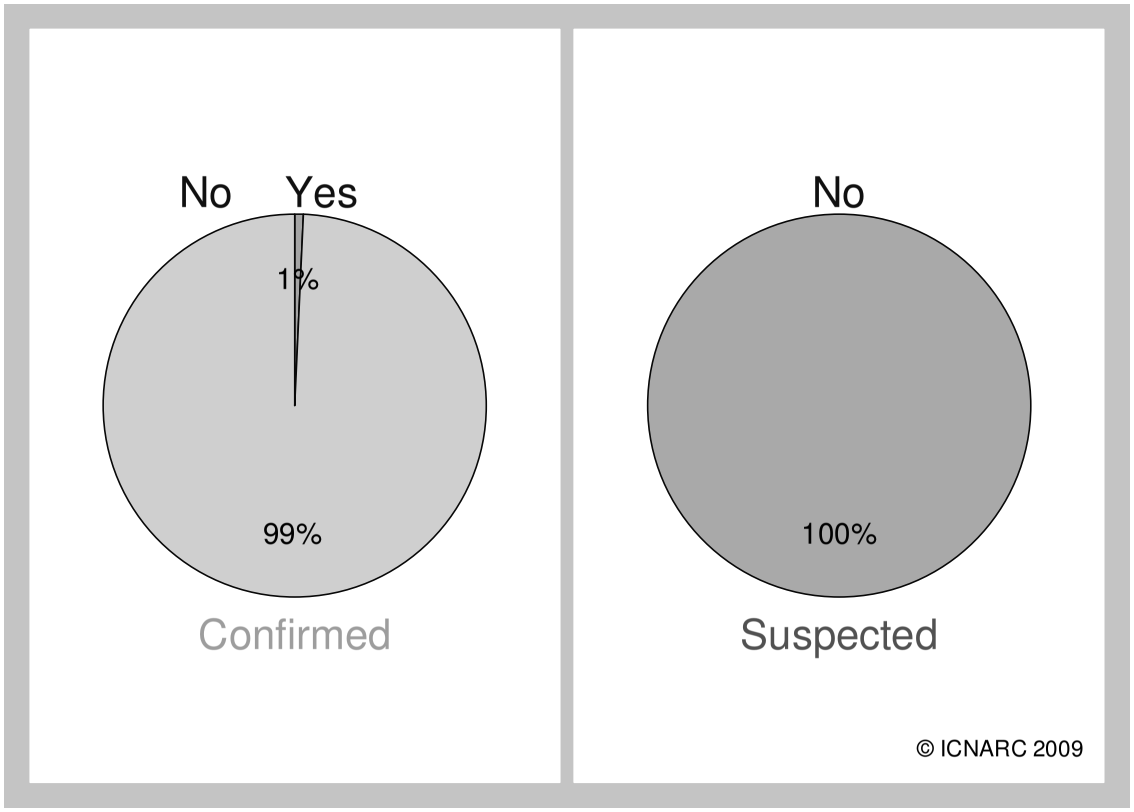
Organ support received at any time – hepatic



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System capacity

- Critical care in receiving hospital 1,144/1,159
  - 11 Transfers
  - 4 Refused critical care
    (1 futile, 2 lack of beds, 1 reason missing)

- Critical care in extended critical care area 31/ 1,083

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Cox proportional hazards model: Time to death

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Variable	Hazard ratio (95% CI)	P value
Age	Non-linear* (see next slide)	< 0.01
Sex: male	1.12 (0.83; 1.51)	0.46
Ethnicity: non-white	1.17 (0.77; 1.79)	0.46
Body composition: overweight (BMI 25-29.9)	1.02 (0.71; 1.47)	0.91
Body composition: obese (BMI 30+)	0.98 (0.64; 1.50)	0.94
Currently or recently pregnant	0.14 (0.02; 1.01)	0.05
Confirmed H1N1	0.98 (0.63; 1.52)	0.92
Antivirals received	0.95 (0.70; 1.30)	0.77
Presentation: secondary bacterial pneumonia†	0.94 (0.63; 1.40)	0.77
Presentation: exacerbation of airflow limitation†	0.59 (0.35; 0.99)	0.05
Presentation: intercurrent illness†	1.15 (0.74; 1.78)	0.53
Emergency department assessment	0.88 (0.62; 1.25)	0.46
Severe chronic organ dysfunction	1.56 (1.08; 2.25)	0.02
Moderate chronic organ dysfunction	1.21 (0.80; 1.81)	0.36
Immunocompromised	1.47 (0.91; 2.35)	0.11
Confusion	0.86 (0.60; 1.22)	0.39
Urea > 7 mmol l^{-1}	1.07 (0.78; 1.46)	0.68
Respiratory rate > 30 min^{-1}	1.09 (0.79; 1.50)	0.61
Systolic BP < 90 mmHg	1.24 (0.79; 1.95)	0.36
Base deficit > 2 mEq l^{-1}	1.09 (0.79; 1.50)	0.59

* restricted cubic spline with 3 degrees of freedom
† relative to viral pneumonitis/ARDS

Hazard ratios >1 indicate factors associated with increased risk
Hazard ratios <1 indicate factors associated with decreased risk

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Cox proportional hazards model: Time to death

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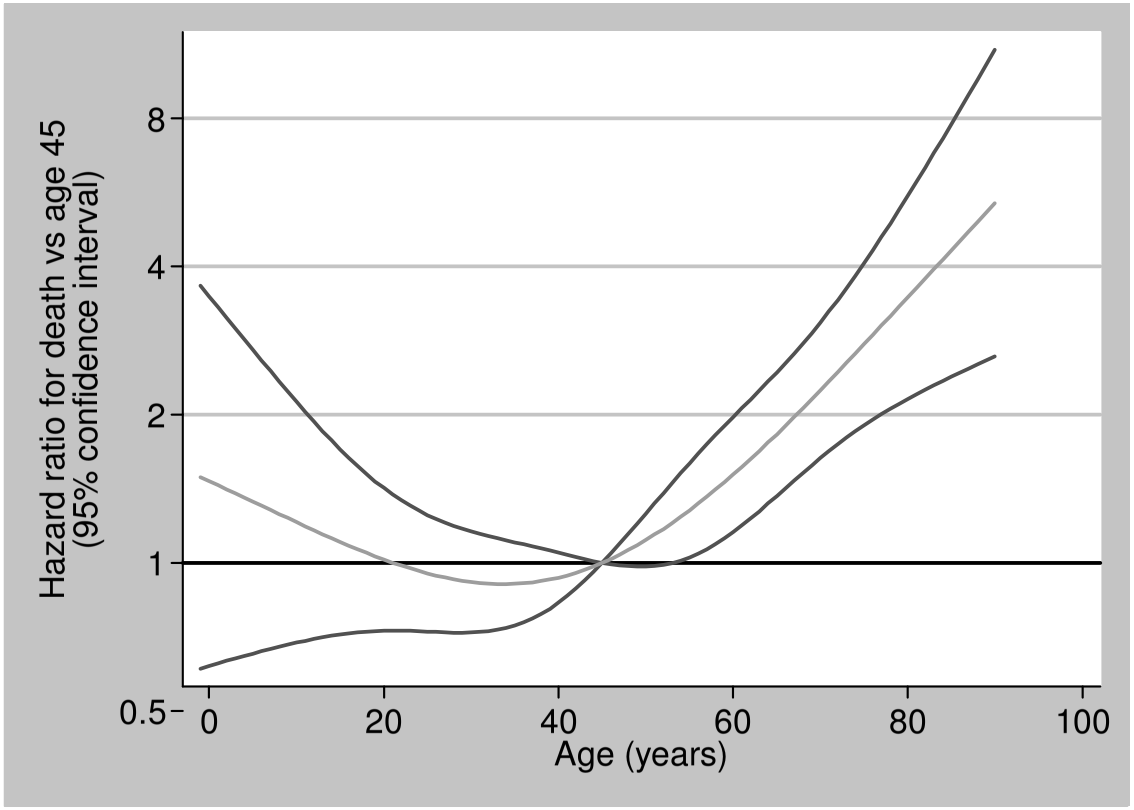

Cox proportional hazards model: Time to end of critical care

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Variable	Hazard ratio (95% CI)	P value
Age	Non-linear* (see next slide)	< 0.01
Sex: male	1.05 (0.90; 1.23)	0.55
Ethnicity: non-white	0.98 (0.80; 1.20)	0.83
Body composition: overweight (BMI 25-29.9)	0.76 (0.62; 0.93)	0.01
Body composition: obese (BMI 30+)	0.87 (0.70; 1.07)	0.18
Currently or recently pregnant	0.84 (0.61; 1.16)	0.29
Confirmed H1N1	0.78 (0.62; 0.97)	0.03
Antivirals received	0.81 (0.69; 0.95)	0.01
Presentation: secondary bacterial pneumonia†	1.18 (0.96; 1.45)	0.11
Presentation: exacerbation of airflow limitation†	1.61 (1.27; 2.03)	< 0.01
Presentation: intercurrent illness†	1.39 (1.10; 1.75)	0.01
Emergency department assessment	1.11 (0.94; 1.31)	0.23
Severe chronic organ dysfunction	0.60 (0.49; 0.73)	< 0.01
Moderate chronic organ dysfunction	0.82 (0.68; 1.00)	0.05
Immunocompromised	0.94 (0.68; 1.29)	0.70
Confusion	0.76 (0.62; 0.92)	0.01
Urea > 7 mmol l^{-1}	0.73 (0.61; 0.87)	< 0.01
Respiratory rate > 30 min^{-1}	0.89 (0.75; 1.05)	0.16
Systolic BP < 90 mmHg	1.21 (0.94; 1.55)	0.13
Base deficit > 2 mEq l^{-1}	0.99 (0.84; 1.17)	0.91

* restricted cubic spline with 3 degrees of freedom
† relative to viral pneumonitis/ARDS

Hazard ratios >1 indicate factors associated with shorter stay
Hazard ratios <1 indicate factors associated with longer stay

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Cox proportional hazards model: Time to end of critical care

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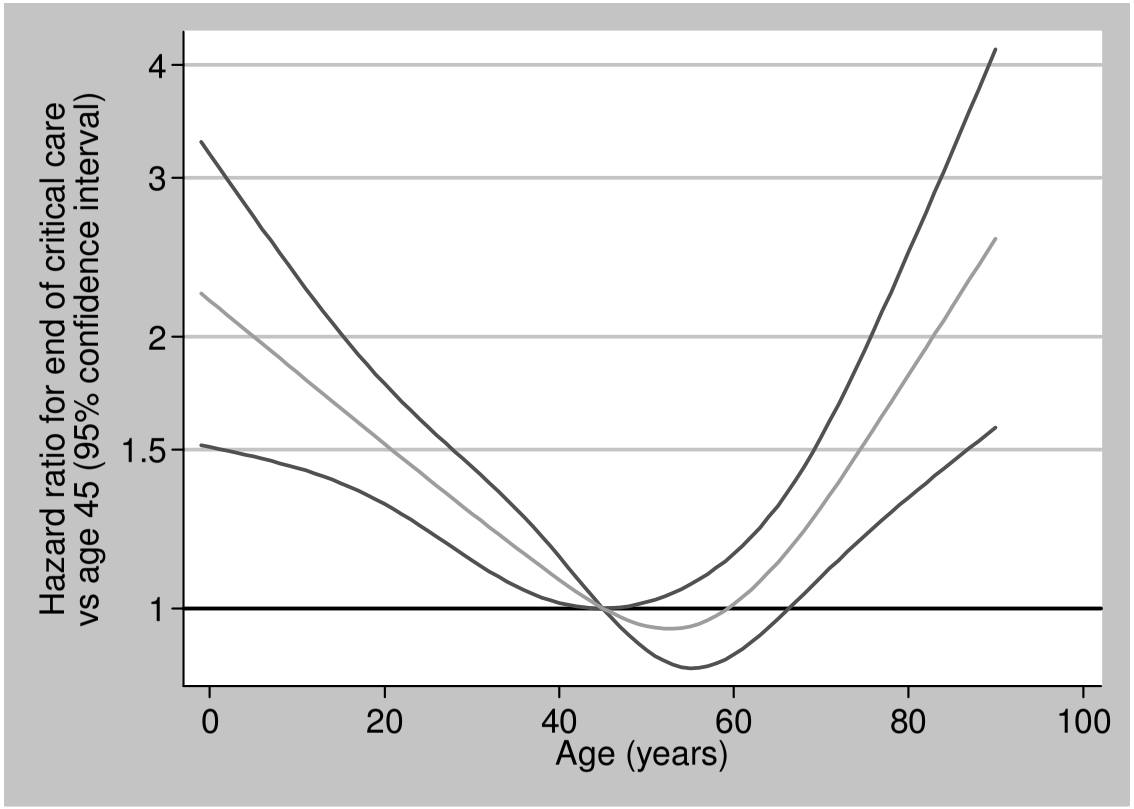

Appendix 4

World Health Organization definitions

Case definitions of H1N1 infection developed by the World Health Organization, Centers for Disease Prevention and Control, and the National Microbiology Laboratory

- *Confirmed*: a person with an acute febrile respiratory illness with laboratory-confirmed influenza A virus infection by real-time PCR or viral culture.
- *Probable*: a person with an acute febrile respiratory illness who is positive for influenza A, but negative for H1 and H3 by influenza real-time PCR; or, positive for influenza A by an influenza rapid test or an influenza immunofluorescence assay and meets criteria for a suspected case.
- *Suspected*: a person with acute febrile respiratory illness with onset within 7 days of close contact with a person who is a confirmed case of influenza A virus infection, or within 7 days of travel to a community either locally or internationally where there are one or more confirmed influenza A cases, or resides in a community where there are one or more confirmed influenza A cases.

Appendix 5
SwiFT protocol

Swine Flu Triage (SwiFT)

Development and ongoing refinement of a triage tool to provide regular information to guide immediate policy and practice for the use of critical care services during the H1N1 swine influenza pandemic.

STUDY PROTOCOL

Version 1.3

3 August 2009

Protocol number: ICNARC/02/01/09
REC reference: 09/H1010/58
NIGB approval number: PIAG2-10(f)/2005

swift@icnarc.org

1. Project summary

Estimates of the requirement for critical care during the current H1N1 swine influenza pandemic indicate that current critical care resources, including any possible surge capacity, could be vastly exceeded. Excessive demand, where resources are finite, creates an ethical dilemma. In this situation, the principles of biomedical ethics and international law dictate that triage be used to guide equitable and efficient resource allocation and that the rationale for triage should be fair and transparent and meet the principles of distributive justice.

Existing, proposed tools for triage of patients considered for critical care have been based on expert opinion, existing severity scores for either general critical care or pneumonia, or developed and/or validated using small, single-centre populations. Consequently, all have limitations regarding their application in the UK NHS.

The SwiFT study has two major components: development and ongoing refinement of triage tools; and ongoing H1N1 swine influenza pandemic-related data collection.

Triage tools will be developed using existing, available data, predominantly the ICNARC Case Mix Programme Database of admissions to adult, general critical care units in England, Wales and Northern Ireland. The primary focus will be on a model to triage all referrals, in order to maintain the principles of distributive justice. All models developed will regularly updated with any relevant data both on H1N1 cases admitted to Case Mix Programme units and emerging from the ongoing H1N1 swine influenza pandemic-related data collection outlined below.

The SwiFT study will establish ongoing H1N1 swine influenza pandemic-related data collection for all patients (adult or paediatric) with confirmed or suspected H1N1 swine influenza referred for critical care, and for patients without confirmed or suspected H1N1 swine influenza that are refused critical care as a direct or indirect result of the pandemic. The dataset will include those variables that are considered able to be rapidly, routinely and accurately collected, even at the peak of the pandemic, and will be informed by all other relevant ongoing activities, both nationally and internationally. Data will be entered locally onto a secure web portal.

The primary purpose of the ongoing H1N1 swine influenza pandemic-related data collection is to allow policy makers within the NHS to assess, in real-time, the burden on critical care services of severe H1N1 swine influenza throughout the NHS and to rapidly respond to escalation in the number of severe cases.

2. Research objectives

(i) To develop triage tools to guide use of critical care services in the UK during the H1N1 swine influenza pandemic using existing, available data, from within and outside ICNARC.

(ii) To establish ongoing H1N1 swine influenza pandemic-related data collection for all patients with confirmed or suspected H1N1 swine influenza referred for critical care, and for patients without confirmed or suspected H1N1 swine influenza that are refused critical care as a direct or indirect result of the pandemic.

(iii) To refine the triage tools, on a regular basis, using emerging data from objective (ii).

(iv) To identify all relevant jurisdictions and establish the content required, and timelines for, regular reporting to guide immediate policy and practice on the use of critical care services during the H1N1 swine influenza pandemic.

(v) To deliver regular reports, plus any ad hoc analyses requested, and participate in H1N1 swine influenza pandemic meetings, as required, and to interact with other pandemic-related activities to maximise use of collected data.

(vi) To publish a final report describing the impact of the H1N1 swine influenza pandemic on critical care services, use and patients' care and outcomes.

3. Background

Potential impact of H1N1 pandemic

On 11 June 2009, the World Health Organization raised the level of influenza pandemic alert from phase 5 to phase 6 indicating the start of an influenza pandemic.[1] H1N1 swine influenza has the potential to cause life threatening illness. However, the likely impact of the pandemic on current critical care capacity is unknown. Estimates of the attack rate, hospitalisation rate and case fatality rate are extremely uncertain.

In the light of these uncertainties, Ercole *et al.*,[2] have attempted to model the likely impact of an H1N1 swine influenza pandemic, lasting twelve weeks, on critical care in England.

Based on disease severity data from the USA[3] and from Mexico,[4] attack rates of 61% for age less than 15 years and 29% for age 15 years or greater (early experience suggests that the attack rate is particularly high in the young) with a hospital admission rate from 0 to 2.0%, were used. The latter exceeded the then current hospital admission rate (0%) for the first 752 cases in England (as of 14 June 2009) and yet, the US hospital admission rate at this time was 9% (95%CI 7 to 12%). Latest estimates from the Health Protection Agency (as of 23 July 2009) indicate the current hospitalisation rate to be 1.7%.[5] Of 840 currently hospitalised patients, 7.5% (n=63) are in critical care. Current estimated attack rate assumptions are for a 20% (10-30%) attack rate over six months, with 50% of those in an eight week period (D Menon, personal communication).

The assumed impact was that 36% of hospital admissions would require critical care and that 50% of these would require ventilatory support (early experience suggests that the H1N1 virus has the potential to elicit an immunologically severe host response). Using age-stratified data for the English population, the peak requirement for critical care for H1N1 swine influenza cases was estimated to be between 0% and 250% of current capacity (current capacity was the sum of total adult Level 3 beds and total paediatric intensive care beds). Peak ventilator usage was estimated to be between 0% and 120% of current capacity (current capacity was assumed to be equal to the number of beds).

Focussing solely on H1N1 swine influenza cases, these estimates suggest that current critical care resources, including any possible surge capacity gained through expansion into Level 2 beds and theatre/recovery settings (addressing only beds and equipment and not availability of trained critical care staff – a likely limitation due to unavailability of trained staff through pandemic-induced illness), could be vastly exceeded.

All projected modelling estimates suggest that current critical care resources may be overwhelmed. Excessive demand, where resources are finite, creates an ethical dilemma and many emergency plans apply a utilitarian approach. In this situation, the principles of biomedical ethics and international law dictate that triage be used to guide equitable and efficient resource allocation and that the rationale for triage should be fair and transparent and meet the principles of distributive justice.

Previous critical care-related triage modelling

For obvious reasons, no H1N1 swine influenza critical care-related triage models exist. However, H5N1 avian influenza did initiate the development of triage models.[6-11]

Existing, proposed tools for triage of patients considered for critical care have been based on expert opinion,[6] existing severity scores for either general critical care (e.g. SOFA)[7,8] or pneumonia (e.g. CURB-65),[9] or developed and/or validated using small, single-centre populations of patients presenting to emergency departments with either community-acquired pneumonias[10] or suspected infection.[11] Current guidance from the Department of Health recognises that there are currently no universally accepted systems available for triage in this context.[12] The guidance focus on the use of a SOFA-based system, but acknowledges that further research in this area is required, and that, in the event a more robust tool is developed, the guidance will be updated.

Many models rely on data relating to chronic health conditions,[6-10] which may be difficult to assess reliably during the peak of the pandemic. In addition, many models use laboratory parameters,[6-9] the measurement of which will be resource-intensive and may delay a triage decision.

Approaches based specifically on models for patients with respiratory infections may be inappropriate, as triage decisions will need to be made for all patients considered for critical care, and not only those with influenza, as a single pool of resources will have to be shared among all patients.[7,13] While the triage tool needs to be simple enough to be applied quickly and consistently during the peak of the pandemic (which may not be the case for SOFA-based tools)[8] it should also be complex enough to be 'scaleable', i.e. able to adjust the decision criteria in order to match demand against capacity.[13] It also needs to be able to match inevitable staff shortages (from staff sickness as well as increased demand) and suboptimal staff expertise (arising from the need to redeploy staff to critical care), against the actual clinical demands posed by patients. For example, the high reported incidence of renal failure in H1N1 infection to date means that staff resource allocation models need to take account of the need to provide renal replacement therapy.

Ongoing national and international efforts

Under the auspices of the Department of Health and the Scientific Advisory Group for Emergencies, the aim of the Flu Clinical Information Network (FLU-CIN), co-ordinated by the University of Nottingham, is to deliver an information collection system that will gather hospital data on H1N1 swine influenza from a network of sentinel hospitals (Imperial, Leicester, Liverpool, Nottingham & Sheffield – with the possibility of expansion). Although the data emerging from the sentinel hospitals will be important, to ensure that sufficient, accurate data on those referred for critical care are available early in the pandemic, there is the need for more widespread data collection if we are to maximise the impact of the early phase of the pandemic to guide ongoing policy and practice on the use of critical care resources during the H1N1 swine influenza pandemic.

At this stage, we are aware of three other major international H1N1 swine influenza pandemic-based data collection projects directly related to the potential demand on critical care resources (in Canada, Australia/New Zealand, and Europe-wide, coordinated by the European Society of Intensive Care Medicine). Regular email and teleconference communication channels have been established and shared learning, experience and documentation has commenced. Established close links between existing national critical care research groups (e.g. in Canada, in Australia/New Zealand, in France, etc.) provide an unrivalled opportunity for coordination of efforts. Standardised data collection and a commitment to rapid accumulation, integration, and analysis of early pandemic data from many countries are planned. One key collaboration is with the Australian and New Zealand Intensive Care Society (ANZICS) Clinical Trials Group. The likely acceleration of the pandemic in the antipodean winter will mean that the information from critical care units in the ANZICS collaboration will be available well in advance of our peak pandemic rates, and could be used to inform and explore our plans for the coming UK winter.

Within these international collaborations, there are many advantages to maintaining a UK-specific data collection. These include: the ability to rapidly disseminate real-time results, both to the Department of Health and other relevant jurisdictions (to inform policy) and to participating hospitals (to inform practice); the ability to rapidly update the dataset to address new knowledge or treatment practices; combining the data collection portal with other UK-specific sources of advice and information; and to do all of this in a framework that adheres to all appropriate UK research governance and data protection arrangements.

4. Study design

Development and ongoing refinement of triage tools

Existing available data within ICNARC

Since 1996, ICNARC has co-ordinated the standardised collection of case mix and outcome data for consecutive admissions to adult, general critical care units in England, Wales and Northern Ireland through the Case Mix Programme. The Case Mix Programme Database (CMPD) currently holds over 800,000 admissions to 209 units (82% coverage). Data completeness and accuracy are promoted by a precise dataset specification with rules and definitions for all variables, regular data collection training courses and extensive local and central data validation. The CMPD will be available for the proposed modelling.

Case mix data in the CMPD include age, acute severity of illness and severe comorbidities. Acute severity of illness is assessed based on the most extreme physiological measurements from the first 24 hours following admission to the critical care unit (see: below). Patients are followed up to ultimate discharge from an acute hospital. Resource use data include the duration of stay in critical care and in hospital, and the duration of support of specific organ systems.

Physiology data in the CMPD include (all values recorded as lowest and highest in the first 24 hours (except where indicated):

- Temperature
- Blood pressure
- Heart rate
- Respiratory rate (ventilated and non-ventilated)
- PaO_2 (lowest) and associated FiO_2, $PaCO_2$, pH
- pH (lowest) and associated $PaCO_2$
- Serum bicarbonate
- Serum sodium
- Serum potassium
- Blood lactate (highest)
- Serum urea (highest)
- Serum creatinine
- Urine output (total)
- Haemoglobin
- White blood cell count

- Platelet count
- Glasgow Coma Score (lowest) and eye, motor and verbal components.

These case mix and outcome data are available for both Level 2 and Level 3 admissions to critical care units. Participating units include both standalone intensive care units and combined intensive care and high dependency units.

Other relevant data held by ICNARC include those accumulated from a small number of NHS hospitals for the evaluation of physiological "track and trigger" systems (e.g. early warning scores)[14] as part of our NIHR SDO funded mixed methods evaluation of the complex intervention termed critical care outreach services.[15] These latter data contain vital signs for patients being assessed for need for critical care, collected pre-critical care and include whether admission to critical care occurred or not. These, too, will inform our models.

Existing available data outside ICNARC

Using our existing national and international links, we will seek any additional relevant data to inform the proposed modelling.

As the Case Mix Programme focuses on the 24-hour period immediately following admission to a critical care unit, the CMPD is suited to answering questions related to the decision to admit the patient to critical care. A second important point on the care pathway, the decision to discharge a patient from critical care (and, in particular, when bed numbers are inadequate who should be discharged to make way for another patient) is beyond the scope of this dataset. We will therefore endeavour to identify other sources of data, external to ICNARC, with serial/daily recording of physiological status and outcome.

Identifying relevant cohorts

It is intended that our models will provide the ability to triage all referrals, or those solely pandemic-related, for critical care; therefore identification of relevant cohorts will reflect this. The primary focus will be on a model to triage all referrals, in order to maintain the principles of distributive justice. Using the CMPD, cohorts can be identified in many ways e.g. by reason for admission to critical care, by source of admission, by prior duration of hospital stay, etc. or using a combination of these. In addition, seasonal data – with particular reference to previous influenza outbreaks – will be investigated.

Initial cohorts will include:

- all referrals model – all admissions to units excluding those following elective surgery and those admitted for pre-surgical physiological optimisation (our rationale is that these activities would be curtailed as part of surge capacity expansion);

- pandemic-related referrals model – admissions to units with a reason for admission representing a community acquired complication of respiratory disease (specified by emerging, international pandemic data on presentation characteristics).

In addition, all units participating in the Case Mix Programme have been requested to submit early data related to any admission with suspected or confirmed H1N1 swine influenza. These data will form another initial cohort for modelling and for comparison with non-H1N1 influenza cases to inform the choice of relevant cohorts for modelling.

These, and other cohorts, may be further refined. Due to the large size of the CMPD, cohorts selected will be based on recent critical care case mix and outcome data to reflect current practice.

Developing the triage tools

Selection of variables to include in the triage models will focus on information we anticipate will be readily available at the peak of the H1N1 swine influenza pandemic. Additional, less readily available variables will be tested for importance and only included if there is the potential for rapid, inexpensive, point-of-care testing e.g. blood lactate.

Selection of outcomes will reflect not only survival but duration of survival and use of critical care resources. Models will reflect both those admissions whose prognostic risk is too low to justify admission to critical care (in particular, those that receive minimal organ support that could be delivered in a non-critical care setting) and also those whose prognosis is too poor. The primary outcome for the development of the triage models will therefore be an ordinal (3-level) outcome on the following scale:

1. Minimal requirement for critical care (acute hospital survivors receiving no advanced respiratory support, advanced cardiovascular support, renal support, liver support or neurological support)
2. Hospital survivors requiring critical care (all other acute hospital survivors)
3. Death before ultimate discharge from an acute hospital.

First 24 hour physiology data will be used to identify factors that discriminate among these three categories in each relevant cohort. Using ordered logistic regression, simple prognostic models will be developed that may be used to underpin triage tools for critical care with a sliding scale depending on the level of alert and pressure on critical care resources.

The ability of the models to discriminate among the three categories will be assessed using the concordance (c index), a natural extension of the area under the receiver operating

characteristic (ROC) curve from binary logistic regression. At each cut-off, the sensitivity, specificity, and positive and negative predictive value will be evaluated and the potential capacity gained (in terms of proportion of critical care bed days saved) resulting from applying the triage model will be estimated using datasets re-sampled from the CMPD, with increased weighting toward admissions with acute exacerbations of respiratory disease (at varying levels to represent different stages and/or severities of the pandemic).

All models developed will be informed by previous work in this area, and performance will be compared, where appropriate, to that of existing models.

All models developed will be regularly updated with any relevant data both on H1N1 cases admitted to Case Mix Programme units and emerging from the ongoing H1N1 swine influenza pandemic-related data collection outlined below.

Ongoing H1N1 swine influenza pandemic-related data collection

Inclusion criteria

All patients (adult or paediatric) referred for critical care, who would be admitted in "usual" circumstances, and either:

A. have confirmed or suspected H1N1 swine influenza and are either refused critical care or receive critical care within or outside a critical care unit; or

B. are refused critical care or receive critical care outside a critical care unit, as a direct or indirect result of the pandemic.

Dataset

The dataset will include those variables that are considered able to be rapidly, routinely and accurately collected, even at the peak of the pandemic, and available at the point of potential referral for critical care. The dataset will be informed by all other relevant ongoing activities, both nationally and internationally. Every effort will be made to ensure that data collected are standardised with, but do not duplicate, these other national activities. Where possible, variables will be compatible with current, ongoing, non-pandemic-related data collection activities within NHS hospitals, both outside and within critical care (e.g. NHS Critical Care Minimum Data Set – CCMDS, Case Mix Programme, Scottish Intensive Care Society Audit Group – SIGSAG, Paediatric Intensive Care Audit Network – PICANet etc.). Relevant and sufficient identifiers (e.g. NHS Number, Case Mix Programme Admission number, SICSAG Admission number, PICANet Admission number, hospital number, etc.) will be collected to allow for data linkage, longer-term follow-up using the NHS Central Register (hopefully

expedited) and subsequent re-retrieval of the admission record at a later date. Patient-based data will be supplemented by data on the outcome of the triage decision, reason for the decision and the location of subsequent care. Patients receiving critical care will have a small dataset of organ support, treatment and organ failure (SOFA) data collected daily for the duration of critical care. Follow-up of patients not receiving critical care and longer-term follow-up of patients receiving critical care will be undertaken centrally using NHS Number.

Data entry

Data will be entered locally onto a secure web portal. Participating hospitals will be expected and encouraged to provide daily updates with respect to patient data entry. The SwiFT portal will include daily entry of patient data but also weekly entry of hospital pandemic response data related to issues involving staff, beds and equipment required for delivering critical care. In this way, hospitals' response to the pandemic will be monitored. The SwiFT portal will also will also provide a route to feed back weekly summary reports on the data to participating hospitals. In addition, regular reports on the epidemiology, risk factors and treatment of H1N1 swine influenza from data emerging, nationally and internationally will be made available. Finally, the SwiFT portal will support a forum to promote exchange of information between clinicians.

Data security

ICNARC meets all NHS data security requirements and is regularly reviewed, both for the Case Mix Programme and for its ongoing research programme, by the National Information Governance Board for Health and Social Care. ICNARC is registered with the Information Commissioner's Office under the Data Protection Act. Full details of system security are available in the SwiFT Systems Level Security Policy.

Reporting

The primary purpose of the ongoing H1N1 swine influenza pandemic-related data collection is to allow policy makers within the NHS to assess, in real-time, the burden on critical care services of severe H1N1 swine influenza throughout the NHS and to rapidly respond to escalation in the number of severe cases.

To facilitate this, all relevant jurisdictions will be contacted (Department of Health, Health Protection Agency, devolved administrations, etc.) and the required content of regular reporting will be established. In addition, timelines for regular reporting, to guide immediate policy and practice on the use of critical care services, will be agreed. Ad hoc reporting will also be available.

It is hoped that ongoing communication and real-time data linkage can occur between all relevant national H1N1 swine influenza pandemic-related data collection activities to increase the information available to inform NHS policy and practice.

The secondary purpose of the ongoing H1N1 swine influenza pandemic-related data collection is, at the end of pandemic, to publish a final report of its impact to inform policy and practice for future pandemics. This will involve both national and international collaboration.

5. Organisation

Study Steering Group

The Study Steering Group (SSG) responsibilities are to approve the study protocol and any amendments, to monitor and supervise the study towards its research objectives, to review relevant information from external sources, and to resolve problems identified by the Study Management Group. Face-to-face meetings will be held at regular intervals determined by need and not less than once a year, with routine business conducted by telephone, email and post. The SSG membership is shown below. Representatives of the funder (NIHR HTA Programme) and the sponsor (ICNARC) will be invited to observe at SSG meetings.

Membership

Professor Kathy Rowan (Chair)	Director, ICNARC
Dr David Harrison	Senior Statistician, ICNARC
Dr Danny McAuley	Senior Lecturer in Intensive Care Medicine, The Queen's University, Belfast
Professor David Menon	Professor of Anaesthesia, University of Cambridge
Dr Gavin Perkins	Associate Professor in Critical Care and Resuscitation, University of Warwick
Dr Bruce Taylor	Consultant in Critical Care Medicine & Anaesthesia, Portsmouth Hospitals NHS Trust

Study Management Group

The day-to-day running of the SwiFT study will be overseen by a Study Management Group (SMG) consisting of the ICNARC staff directly involved in the study. The SMG membership is shown below.

Membership

Professor Kathy Rowan	Director
Dr David Harrison	Senior Statistician
Ms Lucy Lloyd-Scott	Case Mix Programme Manager
Mr Phil Restarick	Research Coordinator

Data monitoring

As the study does not involve any change to usual care for patients, an independent Data Monitoring Committee (DMC) will not be required. The SSG will oversee those responsibilities usually delegated to a DMC.

Service users

The two service user representatives and charity trustees on ICNARC's Board of Management, as ex-critical care patients, will provide this perspective. All involvement of service users in SwiFT will follow the guidelines and recommendations for good practice from INVOLVE (http://www.invo.org.uk).

Ethical arrangements

ICNARC holds approval from the National Information Governance Board for Health and Social Care (NIGB) under Section 251 of the NHS Act 2006 to hold limited patient identifiable data for the Case Mix Programme without consent (approval number: PIAG2-10(f)/2005). NIGB have approved an extension of this existing approval to cover the SwiFT study.

An application to an NHS Research Ethics Committee is pending.

Research governance

The study will be managed according to the Medical Research Council's Guidelines for Good Research Practice (http://www.mrc.ac.uk/pdf-good_research_practice.pdf), Guidelines for Good Clinical Practice in Clinical Trials (http://www.mrc.ac.uk/pdf-ctg.pdf) and Procedure for Inquiring into Allegations of Scientific Misconduct (http://www.mrc.ac.uk/pdf-mis_con.pdf). ICNARC has developed its own policies and procedures based on these MRC guidelines, which are adhered to for all research activities at ICNARC. In addition, ICNARC has contractual confidentiality agreements with all members of staff. Policies regarding alleged scientific misconduct and breach of confidentiality are reinforced by disciplinary procedures. The ICNARC research staff undergoes regular training in Good Clinical Practice (GCP).

Funding

Research costs for this study have been met by a grant from the National Institute for Health Research (NIHR) Health Technology Assessment (HTA) Programme (project reference 09/86/01). NHS Support Costs for data collection will be met through the Comprehensive Local Research Networks (CLRNs) from NIHR contingency funds.

Indemnity

ICNARC holds professional liability insurance (certificate number A05305/0808, Markel International Insurance Co Ltd) to meet the potential legal liability of the sponsor for harm to participants arising from the management of the research. This policy also covers the potential legal liability of ICNARC as both sponsor and employer for harm to participants arising from the design of the research. Indemnity to meet the potential legal liability of investigators/collaborators for harm to participants arising from the conduct of the research is provided by the NHS indemnity scheme or through professional indemnity.

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