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48-hour maximum working week (without averaging) for Junior Doctors in Scotland

Expert Working Group - Final report

Professor Philip Cachia

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Executive Summary:

(Redacted)

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1. Introduction and Background

The Scottish Government is committed to make NHS Scotland attractive for Junior Doctors to work and train in, whilst ensuring they have safe and sustainable work patterns. Junior Doctor rotas must comply with the EU Working Time Regulations and the New Deal contract for Junior Doctors (2002). Additional measures introduced by the Scottish Government to improve Junior Doctors' working lives include reducing the maximum number of consecutive working days to 7, abolishing 7 consecutive night shifts, and ensuring a minimum of 46 hours recovery time after night shifts (*Scottish Government Director's Letter (2018) 16*).

Scottish Government Health Workforce, is implementing a quality improvement (QI) framework that examines the working patterns of doctors-in-training: the Professional Compliance Analysis Tool (PCAT). PCAT evaluates the rota templates and the supporting professional environment across three interdependent domains: Patient Safety, Quality of Training and Trainee Health and Wellbeing.

Working Time Regulations limit the working week to 48 hours but permit the hours to be averaged over a 26 week period. As a result many Junior Doctor rotas in Scotland still include individual weeks with very long hours of work and the associated risks of fatigue. A further commitment from the Scottish Government is the introduction of a 48 hour maximum working week - without averaging - which would mean that no Junior Doctor in Scotland worked more than 48 hours in a seven day period.

In March 2018 the Cabinet Secretary for Health and Sport commissioned an independent Expert Working Group (EWG) to explore the options and changes that would be required to achieve this objective. A chair for the EWG (Philip Cachia) was appointed in March 2018. The Chair worked with Scottish Government advisors to agree on a membership of the EWG that both ensured representation of all relevant stakeholders, and proposed appropriate terms of reference for the group.

An informal workshop was held in September 2018 at which the agreed stakeholders were invited to present key issues, benefits and barriers to achieving the 48 hour objective.

The stakeholders who contributed to this workshop were:

- The Academy of Royal Medical Colleges and Faculties of Scotland (consultant and junior representatives)
- BMA Scotland (two representatives)
- NHS Scotland Management Executive Group (two representatives)
- NHS Education for Scotland (two representatives)
- Health Board Directors of Medical Education (one representative)

Building on the workshop outcomes, the membership was finalised to include the above stakeholder organisations and a public partner, recruited through the Healthcare Improvement Scotland Public Partner programme.

Terms of Reference for the EWG were developed and signed off by the Cabinet Secretary in January 2019 **(Redacted)**.

Formal EWG meetings were held in November 2018, March, May, June, September and November 2019 to take forward an agreed programme of work which makes up the substance of this report. External presentations provided information and evidence on the use of e-rostering and the Professional Analysis Compliance Tool (PCAT) as examples of best practice in rota design in NHS Scotland.

All stakeholders agreed to support the EWG programme of work while noting the following:

1. The EWG programme should initially explore options for best practice rota design to achieve the 48 hour maximum working week (without averaging) objective within existing service and educational models, and with the current Junior Doctor staffing establishments.
2. **(Redacted).**
3. **(Redacted).** There are established UK- and Scotland- wide initiatives that will report on these broader areas. The work of the EWG should be focused on the 48 hour maximum working week (without averaging), taking cognisance of implications for fatigue and wellbeing, while avoiding replicating the work of other initiatives in this area.
4. In making recommendations, the EWG would consider and prioritise the whole system consequences of Junior Doctor rota changes, including the impact on other NHS staff groups, service continuity and patient safety.

It was therefore agreed that the EWG programme of work would consist of the following stages:

(Redacted)

2. Membership of the Junior Doctors 48 hour Expert Working Group

Professor Philip Cachia, Chair
Professor Derek Bell, Scottish Academy of Medical Royal Colleges (Deputy Dr Michael Jones)
Dr Luke Yates, Scottish Academy of Medical Royal Colleges
Mr Sean Gallimore, BMA
Dr Lewis Hughes, BMA
Dr Simon Edgar, Chair, Scottish Directors of Medical Education Group
Mr Daniel McQueen, Healthcare Improvement Scotland, Public Partner
Dr Jane Burns, Management Steering Group (Deputy Dr John Keaney)
Dr Annie Ingram, Management Steering Group
Professor Clare McKenzie, NHS Education for Scotland
Ms Anne Dickson, NHS Education for Scotland

Scottish Government/NHS Education for Scotland Clinical Leadership Fellows

Dr Alex Rice
Dr Chris Sheridan
Dr Katie Ritchie (From August 2019)
Dr Michelle Currie (From August 2019)

Scottish Government Advisors

Dr John Colvin, Professional Adviser and Senior Medical Officer
Mr Daniel MacDonald, Medical Workforce Adviser

3. EWG programme of work

3.1 Design 48 Hour working week rotas with no averaging

Summary of current Junior Doctor rotas in Scotland:

There are over 800 different Junior Doctor rotas in operation across NHS Scotland, covering all grades and specialties, and in settings ranging from large urban teaching/trauma centres to rural and community healthcare.

The current approval process involves:

- Design and endorsement by territorial board Human Resources departments as meeting all applicable employment safeguards, with input from service and medical staff
- Approval for use by Junior Doctor representatives
- Educational approval by NHS Education for Scotland (NES) through the accountable Postgraduate Dean for each programme. (Detailed in section 3.2)
- Approval from the Programme Director of the New Deal Monitoring team, situated within the Scottish Government Health Workforce, Leadership & Service Reform Directorate.

Currently template rotas are prepared in Health Boards on the Doctors Rostering System (DRS), which is a computer-based system that calculates hours worked and ensure rotas meet safeguards set out within legal and contractual rules. The system also ensures compliance with the Working Time Regulations which stipulate a 48-hour maximum working week, averaged over a 26-week period.

Pilot rotas for 48 hour maximum working week:

(Redacted)

3.2 Educational Implications of proposed 48 hour rotas

(Redacted)

3.3. Site visit to Hairmyres University Hospital to explore the impact of proposed 48 hour rotas

(Redacted)

3.4. Evidence on Fatigue and relationship to hours of work and rota design

Whilst the EWG programme of work was focussed on the changes required to implement a 48 hour maximum working week (without averaging) for Junior Doctors, there was agreement that recommendations for change could not be effective or safe without considering the impact proposed changes may have on fatigue.

(Redacted)

Fatigue: What it is and why Junior Doctors are at greater risk

Definitions of fatigue vary in the literature, and the terms tiredness and drowsiness are used interchangeably in a number of publications[1]. We offer two widely accepted definitions:

> "A state of feeling tired, weary, or sleepy that results from prolonged mental and physical work, extended periods of anxiety, exposure to harsh environment, or loss of sleep."[1]

> "Fatigue is the decline in mental and/or physical performance that results from prolonged exertion, lack of quality sleep or disruption of the internal body clock. The degree to which a worker is prone to fatigue is also related to workload. For example, work that requires constant attention, is machine paced, complex or monotonous will increase the risk of fatigue."[2]

(Redacted). In the GMC National Training Survey 2019 (response rate 95% of all UK Doctors in Training) about one in four reported feeling 'burnt out' by their work with 56% reporting that they always or often feel 'worn out' at the end of the day. 45% of trainees report working beyond their rostered hours on a daily or weekly basis; 39% rated their workload as heavy or very heavy[3]. Fatigue and shift working are recognised risk factors for wellbeing and clinical errors. Employers have a legal duty to consider the risks to safety presented by shift work[4].

How fatigue and its contributors impact on Doctor-Patient safety
Fatigue and Working Hours

Longer working hours are associated with greater risk of fatigue[5]. **(Redacted).** Acute fatigue (resulting from extended time on a single shift or time awake without rest) impairs attention, performance and working memory capacity[6]. While it is difficult to accurately determine how the level of risk changes over the period of time worked, there is some consensus from studies of shift workers that longer

shifts (defined as shifts at least 10 or 12 hours long in the literature)[7] are associated with a 25-30% higher risk of accidents and injuries than an eight-hour shift[8–10]. Research specifically in physicians demonstrates an increased risk of road traffic accidents after extended shifts over 24 hours[11], and a higher risk of needlestick injury during extended shifts over 20 hours[12]. An individual who experiences moderate sleep deprivation (equivalent to being awake for 17-19 hours) can have the same reaction time as being at a blood alcohol level of 50mg/100ml (the legal limit for safe driving in many countries including Scotland).[13] In addition, evidence from across shift-working industries shows that working long shifts in succession (eg blocks of seven nights) increases the risk of fatigue and errors, with the risk increasing the more shifts worked consecutively.[8,14]

Junior Doctors in Scotland are currently required to not exceed 48 hours per week averaged over a 26 week reference period. The 48 hour figure takes account of annual and study leave. This requirement relates to the European Working Time Directive and is separate to the contractual limits provided in the New Deal. There is some evidence that the reduction of hours worked to this average is likely to have contributed to improved patient safety, with 33% fewer medical errors in one (relatively small) study.[15] **(Redacted).** Although the study did not explore this issue, trainees reported a reduction in Educational Opportunities.[5] Studies from the US appear to indicate improved safety with reduced working hours, but this was in the context of reducing working hours from 85 to 65 per week.[16–18] Interventions which reduce the working hours of Doctors in Training have not been shown to adversely affect patient mortality, cost of care or the rate of readmission to hospital.[19] Overall the available evidence is limited by variable definitions of “long hours” and differing methods of assessing fatigue levels. The optimal duration of a working week for doctors is unknown.

Personal Health Effects of Fatigue

Over the long term, working long hours, shift work and night work adversely affect the health of workers[20,21]. Specific effects include increased risk of cardiovascular disease[22,23], primary sleep disorders[24], becoming overweight or obese[25], and developing type 2 diabetes[26–28]. Other studies which have included hospital workers have found an increased risk to shift-working women of miscarriage and pre-term birth.[29] Fatigue is a risk factor for burnout[6] , and working long hours may increase the risk of depression and anxiety. Female night-shift workers appear to be at an increased risk of breast cancer[30,31], and night shift work is linked to an elevated risk for prostate[32] and colorectal cancer[33], as well as dementia[34].

Other Risks for Fatigue

(Redacted)

Workload must also be considered. Excessive workload may prevent doctors from taking breaks and also increases the risk of interruptions. Decision fatigue is a recognised acute consequence of high-intensity work.[6] **(Redacted).**

Conclusion

(Redacted)

4. GMC Report - *'Caring for Doctors Caring for Patients: How to transform UK healthcare environments to support doctors and medical students caring for patients' (November 2019)*

In recent years, the evolving crises in medical recruitment and retention, poor job satisfaction and increasing evidence of burnout in the medical profession have been widely recognised as a cause for concern. In response, the GMC commissioned Professor Michael West and Dame Denise Coia to undertake a UK wide review to identify the causes of poor wellbeing in doctors and medical students and help provide solutions that can be actioned in the NHS.

Their report '*Caring for Doctors Caring for Patients: How to transform UK healthcare environments to support doctors and medical students to care for patients'* was published by the GMC in November 2019.

The report makes eight key recommendations focussed on delivering safe, supportive and inclusive environments and compassionate cultures. The authors challenge health service leaders to implement all recommendations in order to improve the wellbeing and sustainability of the medical workforce – an outcome known to correlate with higher quality patient care and higher levels of patient satisfaction.

The GMC report has a much wider scope than the specific focus of the EWG to make recommendations on achieving a 48 hour maximum working week (without averaging) for Junior Doctors. However, two of the key recommendations in '*Caring for Doctors Caring for Patients'* are pertinent to Junior Doctor working hours:

Key recommendation two *(Caring for Doctors Caring for Patients, November 2019)*

Work conditions

To introduce UK-wide minimum standards for basic facilities in healthcare organisations.

● All healthcare employers should provide all doctors with places and time to rest and sleep, access to nutritious food and drink, the tools needed to do their job and should implement the BMA's Fatigue and Facilities charter.

● The leadership and boards of every organisation employing doctors should review facilities to ensure compliance with the BMA's Fatigue and Facilities charter.

● Systems regulators, improvement bodies and partners listed should check that employers have implemented the BMA's Fatigue and Facilities charter in all working environments.

● The GMC should continue to work with partners via the insights and data obtained through their NTS to monitor, assess and support implementation. Where issues are identified, the GMC should work with postgraduate deans, medical royal colleges and employers to ensure they are promptly and fairly addressed.

Key recommendation three *(Caring for Doctors Caring for Patients, November 2019)*

Work schedule and rotas

To introduce UK-wide standards for the development and maintenance of work schedules and rotas based on realistic forecasting that supports safe shift swapping, enables breaks, takes account of fatigue and involves doctors with knowledge of the specialty to consider the demands that will be placed on them.

● NHS England, NHS Wales, NHS Boards in Scotland and the Department of Health (Northern Ireland) should fully implement the BMA's and NHS Employers' Good Rostering Guide (see new deal monitoring guidance in Scotland) in all healthcare environments

● Healthcare organisations across the UK should develop and maintain mechanisms to enable doctors to report rotas that are not compliant with the BMA's and NHS Employers' Good Rostering Guide (see new deal monitoring guidance in Scotland). Guardians of safe working hours in England should encourage doctors in training to raise exception reports about rostering issues and should monitor such exception reports and take steps to address the issues raised

● *Systems regulators, improvement bodies and partners listed vi should check employers have implemented the BMA's and NHS Employers' Good Rostering Guide (see new deal monitoring guidance in Scotland)*
● *The GMC should work with partners listed above to monitor implementation of the BMA's*

The EWG programme of work had been completed when '*Caring for Doctors Caring for Patients*' was published. We did, nonetheless, re-visit the EWG report section *'Evidence of Fatigue and relationship to hours of work and rota design'* and compare our conclusions with the relevant recommendations in the GMC report. The outcome of this confirms great synergy between the findings and recommendations on quality of experience as work and rota design in relation to Junior Doctors fatigue and wellbeing.

'Caring for Doctors Caring for Patients' does not make specific reference to Junior Doctors' hours of work so there are no conclusions or recommendations about a desired or optimum maximum working week.

5. Public Partner Reflections

The primary role of a public partner on the EWG was to ensure the EWG adhered to the Terms of Reference and to provide objective scrutiny of the EWG processes. This section contains Danny McQueen's observations in respect of these. In addition, Danny has added some thoughtful insights and suggestions on the content discussed at EWG meetings which should inform NHS leaders in taking forward the recommendations of the EWG.

Observations from Lay Representative (HIS Public Partner) Daniel McQueen

Summary concerning procedure and outcome

1. The EWG worked in accord with its Terms of Reference.
2. The other members made me very welcome and encouraged me to contribute to the discussions.
3. I was impressed by the positive attitude and active engagement of the various parties represented on the EWG. The Chairman has been excellent in facilitating focused discussions.

(Redacted)

Personal comments as Public Partner, highlighting some of the evidence considered

1. Working week.

(Redacted)

2. Shift duration and actual hours worked by JDs.

(Redacted)

3. Fatigue and rest.

(Redacted)

4. Facilities.

(Redacted)

5. Patient safety and Information Technology (IT)

(Redacted)

6. Supervision and team communication.

(Redacted)

7. Conclusion.

(Redacted)

6. Conclusions and recommendations:

The EWG conclusions and recommendations will be presented in the following sections:

(Redacted)

Outcome:

(Redacted)

Principle Conclusions:

(Redacted)

Implementation and Next Steps:

(Redacted)

7. Acknowledgements:

I would like to thank all members of the working group for their diligence and commitment in taking forward this programme of work and for their willingness to explore different options for achieving the objectives set out in the Terms of Reference.

I would particularly like to thank Danny McQueen as the public partner on the group, for his many thoughtful observations and suggestions and for helping to keep us focussed on the core purpose.

Luke Yates and Lewis Hughes jointly undertook the literature review on evidence based interventions to reduce the risks associated with fatigue.

In addition, I would like to thank Alex Rice and Chris Sheridan, the Scottish Government/NES Clinical Leadership Fellows who participated in the work of the group from the beginning and who spent many hours developing and writing up different rota options for the group.

I would also like to thank Members of the Scottish Government Health Workforce Pay and Conditions team who provided support for the group, including [Redacted , Carolyn McKerracher, Pavel Stroev, Sandra Neil, and [Redacted]

8. Appendices

1. EWG Terms of Reference
2. Hairmyres 48 hour maximum working week pilot rotas
3. Comparison of pre-existing and revised 48 hour maximum Hairmyres rotas
4. NES Educational approval analysis for revised 48 hour maximum Hairmyres rotas
5. Request for Educational Approval of Draft Hairmyres University Hospital Rotas – 48 hour maximum working week (without averaging)
6. Staff feedback from the **(Redacted)** pilot visit
7. NHS Education for Scotland revised rota educational approval checklist
8. References for 'Evidence of Fatigue and relationship to hours of work and rota design
9. Table: benefits and risks of options for achieving a 48 hour maximum working week (without averaging) for Junior Doctors in Scotland
10. Professional Compliance Analysis Tool - PCAT

Appendix 1: Junior Doctors' 48-hour Expert Working Group Terms of Reference

Overview

NHS Scotland is a first class heath service that provides high quality care to the people of Scotland, and is a world leader in the training of Junior Doctors. By enhancing our Junior Doctors working lives, health and well-being, we can contribute to a sustainable workforce that delivers a high level of training, professionalism, clinical care, and safe working practices. To achieve this, Scotland requires:

• A high quality, motivated Junior Doctor work force which contributes to safe and effective healthcare supported by high quality postgraduate training and best employment practice.
• Best practice guidance and compliance to rota design that balances education and training requirements with medical service continuity whilst recognising and supporting the work life balance of Junior Doctors
• A safe operational level of Junior Doctor vacancies across all disciplines – an organisation the size of NHS Scotland, will always have vacancies, but within any discipline, these must be kept minimal and managed to ensure clinical safety and reduce fatigue and stress for Junior Doctors.

• To reduce the demand for temporary staff and the associated costs

Fatigue is recognised as a significant risk inherent to Junior Doctor working, with resultant effects on Junior Doctor safety and wellbeing, retention and absences and patient safety. Progress has already been achieved on improving the working lives of Junior Doctors, by ending the practice of working for seven successive nights, reducing the average maximum number of hours from 58 to 48, introducing (from August 2019) a minimum break of 46 hours following full shift night working and the provision of single employer status for Junior Doctors through the Shared Service programme.

EWG Purpose

It is proposed that the Junior Doctors' 48-hour Expert Working Group will develop risk assessed options for implementing a 48-hour working week (without averaging) taking into consideration Junior Doctor wellbeing, the effects on education and training, continuity of safe and effective service provision and the impact on other staff.

The Group will take a phased approach to how best to develop potential solutions taking into account associated risks and potential mitigation, reporting as outcomes are achieved or significant stages are reached. The initial phase will be to consider the existing rotas and how they impact on patient safety, training, resources and the effect of fatigue by:

• Evaluating available evidence on optimal rota design taking into account the priorities of continuity of excellence in patient care, training and education and the wellbeing of Junior Doctors.
• Analysing and modelling of current Junior Doctor rotas across Scotland, with the aim of identifying best practice and the reasons for variation in practice
• Liaising with other groups working on overlapping areas relating to staff wellbeing to ensure coordinated and consistent workstreams and objectives
• Working with NHS service and medical managers (across different geographies and specialties) to explore opportunities to pilot and evaluate potential rota innovations and changes that work towards the objective of a safe 48 hour maximum working week and the impact on patient care, training and education and Junior Doctor wellbeing.
• Developing recommendations for best practice in rota design and innovation with the aim of reducing Junior Doctors' hours and improving their working lives, taking into account the impact on service continuity, other staff groups and flexible bank/agency arrangements. (Recognising that different solutions will be required in different health service settings and across different specialties).
• Recommending best practice on rota design across appropriate areas of the NHS.

• Identify potential barriers to effective implementation and make risk assessed recommendations to overcome these.
• identifying the data and information required to monitor and support improvements in the working lives and conditions of Junior Doctors and recommend the processes necessary to support this.

Throughout this time the Group will keep abreast of Workforce Plans and Service Delivery and any potential impact of proposals on the work of the Group. At the end of this phase the Group will report on their findings and suggest proposals for consideration. It may be necessary to initiate further phases involving wider considerations; these will be detailed in the report and would require to be scoped out.

Membership

EWG Membership comprising:
• Independent chair, appointed by Scottish Ministers
• British Medical Association
• Academy of Royal Colleges and Faculties of Scotland
• NHS Education for Scotland
• Directors of Medical Education
• NHS Scotland Management Steering Group
• HIS Public Partner
The Group will consult with/involve other relevant organisations and individuals as appropriate.

Timings

The EWG is expected to draw preliminary conclusions and make recommendations to the Cabinet Secretary for Health and Sport from the initial phase by December 2019.

Appendix 2: Hairmyres 48 hour maximum (without averaging) working week pilot rotas and analysis:

(Redacted)

Appendix 3: Comparison of pre-existing and revised 48 hour maximum (without averaging) working week rotas for Hairmyres pilot study.

(Redacted)

Appendix 4: NES Junior Doctor rota Educational Approval Checklist, 2019

(Redacted)

Appendix 5. Request for Educational Approval of Draft Hairmyres University Hospital Rotas – 48 hour maximum working week (without averaging) (Professor Clare McKenzie in consultation with other Postgraduate Deans)

(Redacted)

Appendix 6: Staff feedback from the (Redacted) pilot visit

(Redacted)

Appendix 7: Rota exercise at Hairmyres Hospital

(Redacted)

Appendix 8. References for 'Evidence of Fatigue and relationship to hours of work and rota design

1. Yazdi Z, Sadeghniiat-Haghighi K. Fatigue management in the workplace [Internet]. Industrial Psychiatry Journal2015;24(1):12. Available from: http://dx.doi.org/10.4103/0972-6748.160915

2. Krueger GP. Sustained work, fatigue, sleep loss and performance: A review of the issues. Work & Stress 1989;3(2):129–41.

3. General Medical Council. National Training Survey 2019: Initial Findings Report [Internet]. 2019. Available from: https://prodsitecore.gmc-uk.org/-/media/national-training-surveys-initial-findings-report-20190705_2.pdf?la=en&hash=9FFCD9354033B5C2CBBB1B672CCFFFD79D9B2FEF

4. Health, Executive S. Managing shiftwork-Health and safety guidance. 2006;

5. Morrow G, Burford B, Carter M, Illing J. The impact of the working time regulations on medical education and training: literature review. Durham: Centre for Medical Education Research [Internet] 2012;Available from: https://pdfs.semanticscholar.org/52bb/81b75644873a30f824079ce5472f044df88a.pdf

6. British Medical Association. Fatigue and sleep deprivation – the impact of different working patterns on doctors [Internet]. 2018. Available from: https://www.bma.org.uk/-/media/files/pdfs/collective%20voice/policy%20research/education%20and%20training/fatigue-sleep-deprivation-briefing-jan2017.pdf?la=en

7. Caruso CC. Possible broad impacts of long work hours. Ind Health 2006;44(4):531–6.

8. Folkard S, Tucker P. Shift work, safety and productivity. Occup Med 2003;53(2):95–101.

9. Folkard S, Lombardi DA. Toward a “Risk Index” to Assess Work Schedules. Chronobiol Int 2004;21(6):1063–72.

10. Folkard S, Robertson KA, Spencer MB. A Fatigue/Risk Index to assess work schedules. Somnologie - Schlafforschung und Schlafmedizin 2007;11(3):177–85.

11. Barger LK, Cade BE, Ayas NT, Cronin JW, Rosner B, Speizer FE, et al. Extended work shifts and the risk of motor vehicle crashes among interns. N Engl J Med 2005;352(2):125–34.

12. Ayas NT, Barger LK, Cade BE, Hashimoto DM, Rosner B, Cronin JW, et al. Extended work duration and the risk of self-reported percutaneous injuries in interns. JAMA 2006;296(9):1055–62.

13. Williamson AM, Feyer AM. Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. Occup Environ Med 2000;57(10):649–55.

14. Folkard S, Lombardi DA, Tucker PT. Shiftwork: safety, sleepiness and sleep. Ind Health 2005;43(1):20–3.

15. Cappuccio FP, Bakewell A, Taggart FM, Ward G, Ji C, Sullivan JP, et al. Implementing a 48 h EWTD-compliant rota for junior doctors in the UK does not compromise patients’ safety: assessor-blind pilot comparison. QJM 2009;102(4):271–82.

16. Landrigan CP, Rothschild JM, Cronin JW, Kaushal R, Burdick E, Katz JT, et al. Effect of reducing interns' work hours on serious medical errors in intensive care units. N Engl J Med 2004;351(18):1838–48.

17. Barger LK, Ayas NT, Cade BE, Cronin JW, Rosner B, Speizer FE, et al. Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. PLoS Med 2006;3(12):e487.

18. Lockley SW, Cronin JW, Evans EE, Cade BE, Lee CJ, Landrigan CP, et al. Effect of reducing interns' weekly work hours on sleep and attentional failures. N Engl J Med 2004;351(18):1829–37.

19. Jena AB, Farid M, Blumenthal D, Bhattacharya J. Association of residency work hour reform with long term quality and costs of care of US physicians: observational study [Internet]. BMJ2019;l4134. Available from: http://dx.doi.org/10.1136/bmj.l4134

20. Kecklund G, Axelsson J. Health consequences of shift work and insufficient sleep. BMJ 2016;355:i5210.

21. Bannai A, Tamakoshi A. The association between long working hours and health: a systematic review of epidemiological evidence. Scand J Work Environ Health 2014;40(1):5–18.

22. Vyas MV, Garg AX, Iansavichus AV, Costella J, Donner A, Laugsand LE, et al. Shift work and vascular events: systematic review and meta-analysis. BMJ 2012;345:e4800.

23. Virtanen M, Heikkilä K, Jokela M, Ferrie JE, Batty GD, Vahtera J, et al. Long working hours and coronary heart disease: a systematic review and meta-analysis. Am J Epidemiol 2012;176(7):586–96.

24. Anothaisintawee T, Reutrakul S, Van Cauter E, Thakkinstian A. Sleep disturbances compared to traditional risk factors for diabetes development: Systematic review and meta-analysis. Sleep Med Rev 2016;30:11–24.

25. van Drongelen A, Boot C, Merkus S, Smid T, Beek AJ. The effects of shift work on body weight change − a systematic review of longitudinal studies [Internet]. Scandinavian Journal of Work, Environment & Health2011;37(4):263–75. Available from: http://dx.doi.org/10.5271/sjweh.3143

26. Gan Y, Yang C, Tong X, Sun H, Cong Y, Yin X, et al. Shift work and diabetes mellitus: a meta-analysis of observational studies. Occup Environ Med 2015;72(1):72–8.

27. Proper KI, van de Langenberg D, Rodenburg W, Vermeulen RCH, van der Beek AJ, van Steeg H, et al. The Relationship Between Shift Work and Metabolic Risk Factors: A Systematic Review of Longitudinal Studies. Am J Prev Med 2016;50(5):e147–57.

28. Knutsson A, Kempe A. Shift work and diabetes – A systematic review [Internet]. Chronobiology International2014;31(10):1146–51. Available from:

http://dx.doi.org/10.3109/07420528.2014.957308

29. Davari MH, Naghshineh E, Mostaghaci M, Mirmohammadi SJ, Bahaloo M, Jafari A, et al. Shift Work Effects and Pregnancy Outcome: A Historical Cohort Study. J Family Reprod Health 2018;12(2):84–8.

30. He C, Anand ST, Ebell MH, Vena JE, Robb SW. Circadian disrupting exposures and breast cancer risk: a meta-analysis. Int Arch Occup Environ Health 2015;88(5):533–47.

31. Lin X, Chen W, Wei F, Ying M, Wei W, Xie X. Night-shift work increases morbidity of breast cancer and all-cause mortality: a meta-analysis of 16 prospective cohort studies. Sleep Med 2015;16(11):1381–7.

32. Rao D, Yu H, Bai Y, Zheng X, Xie L. Does night-shift work increase the risk of prostate cancer? a systematic review and meta-analysis. Onco Targets Ther 2015;8:2817–26.

33. Wang X, Ji A, Zhu Y, Liang Z, Wu J, Li S, et al. A meta-analysis including dose-response relationship between night shift work and the risk of colorectal cancer [Internet]. Oncotarget2015;6(28). Available from: http://dx.doi.org/10.18632/oncotarget.4502

34. Bokenberger K, Sjölander A, Dahl Aslan AK, Karlsson IK, Åkerstedt T, Pedersen NL. Shift work and risk of incident dementia: a study of two population-based cohorts. Eur J Epidemiol 2018;33(10):977–87.

35. Monk TH, Folkard S. Making Shiftwork Tolerable. CRC Press; 1992.

36. Akerstedt T. Shift work and disturbed sleep/wakefulness [Internet]. Occupational Medicine2003;53(2):89–94. Available from: http://dx.doi.org/10.1093/occmed/kqg046

37. Pilcher JJ, Lambert BJ, Huffcutt AI. Differential Effects of Permanent and Rotating Shifts on Self-Report Sleep Length: A Meta-Analytic Review [Internet]. Sleep2000;23(2):1–9. Available from: http://dx.doi.org/10.1093/sleep/23.2.1b

38. Sallinen M, Kecklund G. Shift work, sleep, and sleepiness - differences between shift schedules and systems [Internet]. Scandinavian Journal of Work, Environment & Health2010;36(2):121–33. Available from: http://dx.doi.org/10.5271/sjweh.2900

39. Wright KP Jr, Bogan RK, Wyatt JK. Shift work and the assessment and management of shift work disorder (SWD). Sleep Med Rev 2013;17(1):41–54.

40. Vedaa Ø, Harris A, Bjorvatn B, Waage S, Sivertsen B, Tucker P, et al. Systematic review of the relationship between quick returns in rotating shift work and health-related outcomes. Ergonomics 2016;59(1):1–14.

41. West M, Coia D. Caring for doctors Caring for patients [Internet]. General Medical Council; 2019. Available from: https://www.gmc-uk.org/-/media/documents/caring-for-doctors-caring-for-patients_pdf-80706341.pdf

42. Fletcher KE, Saint S, Mangrulkar RS. Balancing continuity of care with residents' limited work hours: defining the implications. Acad Med 2005;80(1):39–43.

Appendix 9. Benefits and risks of options for achieving a 48 hour maximum (without averaging) working week for Junior Doctors in Scotland

(Redacted)

Appendix 10: Professional Compliance Analysis Tool

(Redacted)