KEMENTERIAN PENDIDIKAN, KEBUDAYAAN,
RISET, DAN TEKNOLOGI
UNIVERSITAS JENDERAL SOEDIRMAN
Jalan Prof. Dr. Bunyamin No. 708 Kotak Pos 115 – Purwokerto 53122
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KEPUTUSAN REKTOR UNIVERSITAS JENDERAL SOEDIRMAN
NOMOR 2131/UN23/PT.01.02/2022

TENTANG

PELAKSANA PENELITIAN DASAR UNGGULAN PERGURUAN TINGGI
UNIVERSITAS JENDERAL SOEDIRMAN TAHUN ANGGARAN 2022

REKTOR UNIVERSITAS JENDERAL SOEDIRMAN,

Menimbang :

a. bahwa berdasarkan Kontrak Pelaksanaan Program Penelitian Lanjutan Tahun Anggaran 2022 Program Penelitian Terapan Unggulan Perguruan Tinggi antara Direktorat Riset, Teknologi dan Pengabdian kepada Masyarakat, Direktorat Jenderal Pendidikan Tinggi, Riset, dan Teknologi dengan Ketua Lembaga Penelitian dan Pengabdian Kepada Masyarakat Unsoed Nomor 024/E5/PG.02.00.PT/2022;
b. bahwa berdasarkan Kontrak Pelaksanaan Program Penelitian Tahun Anggaran 2022 Program Penelitian Terapan Unggulan Perguruan Tinggi antara Direktorat Riset, Teknologi dan Pengabdian Masyarakat, Direktorat Jenderal Pendidikan Tinggi, Riset, dan Pengabdian Masyarakat dengan Ketua Lembaga Penelitian dan Pengabdian Kepada Masyarakat Unsoed Nomor 111/E5/PG.02.00/2022;
c. bahwa berdasarkan Kontrak Pelaksanaan Program Penelitian Tahun Anggaran 2022 Program Penelitian Terapan Unggulan Perguruan Tinggi antara Direktorat Riset, Teknologi dan Pengabdian Masyarakat, Direktorat Jenderal Pendidikan Tinggi, Riset, dan Pengabdian Masyarakat dengan Ketua Lembaga Penelitian dan Pengabdian Kepada Masyarakat Unsoed Nomor 216/E5/PG.02.00.PT/2022;
d. bahwa perguruan tinggi mempunyai tugas menyelenggarakan pendidikan, penelitian, dan pengabdian kepada masyarakat;
e. bahwa untuk memenuhi kualitas dan kuantitas penelitian di Universitas Jenderal Soedirman, maka perlu dilakukan penelitian secara kompetitif dan memenuhi standar mutu;
f. bahwa untuk itu perlu diangkat pelaksana Penelitian Dasar Unggulan Perguruan Tinggi dengan Keputusan Rektor Universitas Jenderal Soedirman;

Mengingat :

1. Undang-Undang RI Nomor 5 Tahun 2014 tentang Aparatur Sipil Negara;
2. Undang-Undang RI Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional;
3. Undang-Undang RI Nomor 12 Tahun 2012 tentang Pendidikan Tinggi;
4. Peraturan Pemerintah RI Nomor 4 Tahun 2014 tentang Penyelenggaraan Pendidikan Tinggi dan Pengelolaan Perguruan Tinggi;
5. Keputusan Presiden Republik Indonesia Nomor 195 Tahun 1963 jo Kept. Menteri PTIP No. 153 Tahun 1963 tentang Pendirian Unsoed;

6. Peraturan Menteri Riset, Teknologi, dan Pendidikan Tinggi Nomor 28 Tahun 2017 tentang Statuta Universitas Jenderal Soedirman;
7. Peraturan Menteri Riset, Teknologi, dan Pendidikan Tinggi RI Nomor 10 Tahun 2016 jo Nomor 23 Tahun 2017 tentang Organisasi dan Tata Kerja Unsoed;
8. Peraturan Menteri Keuangan RI Nomor 39/PMK.02/2021 tentang Standar Biaya Keluaran (SBK) Tahun Anggaran 2022;
9. Keputusan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi RI Nomor 26500/MPK.A/KP.07.00/2022 tanggal 14 April 2022 tentang Pemberhentian dan Pengangkatan Rektor Universitas Jenderal Soedirman Periode Tahun 2022 – 2026;

MEMUTUSKAN :

Menetapkan	:	KEPUTUSAN REKTOR UNIVERSITAS JENDERAL SOEDIRMAN TENTANG PELAKSANA PENELITIAN DASAR UNGGULAN PERGURUAN TINGGI UNIVERSITAS JENDERAL SOEDIRMAN TAHUN ANGGARAN 2022.
KESATU	:	Menugaskan kepada dosen yang namanya tercantum dalam lampiran keputusan ini untuk melaksanakan penelitian yang judul, biaya, waktu dan tugas dalam penelitian masing-masing termaktub dalam keputusan ini selanjutnya disebut "Peneliti".
KEDUA	:	Dalam melaksanakan tugasnya "Peneliti" membuat laporan dan bertanggung jawab kepada Rektor Universitas Jenderal Soedirman.
KETIGA	:	Penelitian dilakukan selama 8 (Delapan) bulan mulai 16 Maret 2022 sampai dengan 20 November 2022.
KEEMPAT	:	Biaya pelaksanaan penelitian dibebankan kepada DIPA Direktorat Riset, Teknologi, dan Pengabdian kepada Masyarakat Direktorat Jenderal Pendidikan Tinggi, Riset, dan Teknologi Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi.
KELIMA	:	Keputusan ini mulai berlaku pada tanggal ditetapkan.

Ditetapkan di Purwokerto
Pada tanggal, 10 Agustus 2022

REKTOR,

AKHMAD SODIQ

-lppm/unsoed/dyt

LAMPIRAN
KEPUTUSAN REKTOR
UNIVERSITAS JENDERAL SOEDIRMAN
NOMOR 2131/UN23/PT. 01.02/2022
TANGGAL 10 AGUSTUS 2022
TENTANG
PELAKSANA PENELITIAN DASAR UNGGULAN PERGURUAN TINGGI
UNIVERSITAS JENDERAL SOEDIRMAN TAHUN ANGGARAN 2022

No	Personalia	Jabatan	Judul Penelitian	Dana Disetujui (Rp)	Fakultas	Keterangan
1	Dwi Sunu Widyartini Achmad Ilalqisny Insan Hexa Aprilliana Hidayah	Ketua Peneliti Anggota Peneliti I Anggota Peneliti II	Eksplorasi Dan Pemanfaatan Phaeophyceae Asal Pesisir Kebumen Dalam Upaya Difersifikasi Sumberdaya Alginat Berkelanjutan	88.830.000	Biologi	Lanjutan
2	Mekar Dwi Anggraeni Amin Fatoni Eni Rahmawati	Ketua Peneliti Anggota Peneliti I Anggota Peneliti II	Pengembangan Aplikasi untuk Deteksi Dini Hiperbilirubinemia pada Bayi Baru Lahir	114.436.000	Ilmu-Ilmu Kesehatan	Lanjutan
3	Agus Nuryanto Dian Bhagawati Aswi Andriasari Rofiqoh	Ketua Peneliti Anggota Peneliti I Anggota Peneliti II	Menelisik Keberadaan Ikan Atlantic Seabream, Sparus aurata Di Wilayah Pengelolaan Perikanan Negara Republik Indonesia 573	118.000.000	Biologi	Baru
4	Joko Mulyanto Lantip Rujito Pugud Samodro	Ketua Peneliti Anggota Peneliti I Anggota Peneliti II	Peningkatan Akses Layanan Prolanis Untuk Menurunkan Komplikasi Diabetes Pada Peserta JKN Di Kabupaten Banyumas	220.000.000	Kedokteran	Tahap 2
5	Amin Fatoni Mekar Dwi Anggraeni Eni Rahmawati	Ketua Peneliti Anggota Peneliti I Anggota Peneliti II	Pengembangan Perangkat Dapat Pakai (*Wearable Device*) Pendeteksi dan Pemantauan Bayi Kuning	158.000.000	MIPA	Tahap 2

Ditetapkan di Purwokerto
REKTOR,

AKHMAD SODIQ

-lppm/unsoed/dyt

LAPORAN AKHIR
PENELITIAN DASAR UNGGULAN PERGURUAN TINGGI

Pengembangan Aplikasi untuk Deteksi Dini Hiperbilirubinemia pada Bayi Baru Lahir

Tahun ke 1 dari rencana 2 tahun

OLEH:

Ns. Mekar Dwi Anggraeni, S.Kep., M.Kep., Ph.D

Ns. Eni Rahmawati, S.Kep., M.Kep

Amin Fatoni, Ph.D

LEMBAGA PENELITIAN DAN PENGABDIAN KEPADA MASYARAKAT

UNIVERSITAS JENDERAL SOEDIRMAN

PURWOKERTO

2021

Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi
Jalan Jenderal Sudirman, Senayan, Jakarta Pusat 10270
http://simlitabmas.kemdikbud.go.id/

LAPORAN AKHIR PENELITIAN MULTI TAHUN

ID Proposal: 0602e1f5-2319-4cfe-9b42-c174eb4cde52
Laporan Akhir Penelitian: tahun ke-1 dari 2 tahun

1. IDENTITAS PENELITIAN

A. JUDUL PENELITIAN

Pengembangan Aplikasi untuk Deteksi Dini Hiperbilirubinemia pada Bayi Baru Lahir

B. BIDANG, TEMA, TOPIK, DAN RUMPUN BIDANG ILMU

Bidang Fokus RIRN / Bidang Unggulan Perguruan Tinggi	Tema	Topik (jika ada)	Rumpun Bidang Ilmu
Pangan, gizi dan kesehatan (food, nutrition and health)	-	Pangan, gizi dan kesehatan (food, nutrition and health)	Ilmu Keperawatan

C. KATEGORI, SKEMA, SBK, TARGET TKT DAN LAMA PENELITIAN

Kategori (Kompetitif Nasional/ Desentralisasi/ Penugasan)	Skema Penelitian	Strata (Dasar/ Terapan/ Pengembangan)	SBK (Dasar, Terapan, Pengembangan)	Target Akhir TKT	Lama Penelitian (Tahun)
Penelitian Desentralisasi	Penelitian Dasar Unggulan Perguruan Tinggi	SBK Riset Dasar	SBK Riset Dasar	3	2

2. IDENTITAS PENGUSUL

Nama, Peran	Perguruan Tinggi/ Institusi	Program Studi/ Bagian	Bidang Tugas	ID Sinta	H-Index
MEKAR DWI ANGGRAENI Ketua Pengusul	Universitas Jenderal Soedirman	Profesi Ners		5984154	4
AMIN FATONI S.Si, M.Si, Ph.D Anggota Pengusul 1	Universitas Jenderal Soedirman	Kimia	Pengembang biosensor	7088	7
ENI RAHMAWATI S.Kep, Ners, M.Kep. Anggota Pengusul 2	Universitas Jenderal Soedirman	Ilmu Keperawatan	Menentukan bayi yang dijadikan responden penelitian, koordinasi dengan rumah sakit dan tenaga kesehatan tempat dilakukan pengambilan data	6094294	3

3. MITRA KERJASAMA PENELITIAN (JIKA ADA)

Pelaksanaan penelitian dapat melibatkan mitra kerjasama, yaitu mitra kerjasama dalam melaksanakan penelitian, mitra sebagai calon pengguna hasil penelitian, atau mitra investor

Mitra	Nama Mitra

4. LUARAN DAN TARGET CAPAIAN

Luaran Wajib

Tahun Luaran	Jenis Luaran	Status target capaian (*accepted, published, terdaftar atau granted, atau status lainnya*)	Keterangan (*url dan nama jurnal, penerbit, url paten, keterangan sejenis lainnya*)
1	Artikel pada Conference/Seminar Internasional di Pengindeks Bereputasi	Terbit dalam Prosiding	Joint Conference on Chemistry
1	Artikel pada Conference/Seminar Internasional di Pengindeks Bereputasi	Terbit dalam Prosiding	International Conference of Multidisciplinary and Applied Sciences
1	Artikel pada Conference/Seminar Internasional di Pengindeks Bereputasi	Terbit dalam Prosiding	International Conference of Health Sciences

Luaran Tambahan

Tahun Luaran	Jenis Luaran	Status target capaian (*accepted, published, terdaftar atau granted, atau status lainnya*)	Keterangan (*url dan nama jurnal, penerbit, url paten, keterangan sejenis lainnya*)
1	Dokumen pendaftaran hak cipta	Terbit Sertifikat	Software Smartphone berbasis Android untuk Memprediksi Kadar Bilirubin Bayi

5. ANGGARAN

Rencana anggaran biaya penelitian mengacu pada PMK yang berlaku dengan besaran minimum dan maksimum sebagaimana diatur pada buku Panduan Penelitian dan Pengabdian kepada Masyarakat Edisi 12.

Total RAB 2 Tahun Rp. 281,915,000

Tahun 1 Total Rp. 138,870,000

Jenis Pembelanjaan	Item	Satuan	Vol.	Biaya Satuan	Total
Analisis Data	HR Pengolah Data	P (penelitian)	4	1,500,000	6,000,000
Analisis Data	Honorarium narasumber	OJ	4	900,000	3,600,000
Bahan	Barang Persediaan	Unit	2	3,500,000	7,000,000
Bahan	Bahan Penelitian (Habis Pakai)	Unit	3	500,000	1,500,000
Bahan	ATK	Paket	4	730,000	2,920,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Biaya Publikasi artikel di Jurnal Nasional	Paket	1	1,500,000	1,500,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Publikasi artikel di Jurnal Internasional	Paket	1	15,000,000	15,000,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	HR Sekretariat/Administrasi Peneliti	OB	2	600,000	1,200,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Luaran KI (paten, hak cipta dll)	Paket	2	1,500,000	3,000,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Biaya seminar nasional	Paket	3	1,000,000	3,000,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Biaya seminar internasional	Paket	3	3,000,000	9,000,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Biaya konsumsi rapat	OH	30	50,000	1,500,000
Pengumpulan Data	Tiket	OK (kali)	2	2,500,000	5,000,000

Jenis Pembelanjaan	Item	Satuan	Vol.	Biaya Satuan	Total
Pengumpulan Data	HR Pembantu Peneliti	OJ	77	250,000	19,250,000
Pengumpulan Data	Biaya konsumsi	OH	150	50,000	7,500,000

6. HASIL PENELITIAN

A. RINGKASAN: Tuliskan secara ringkas latar belakang penelitian, tujuan dan tahapan metode penelitian, luaran yang ditargetkan, serta uraian TKT penelitian.

Latar belakang penelitian ini adalah Angka Kematian Bayi di Indonesia saat ini adalah sebesar 26,9 yang artinya terdapat 26,9 bayi meninggal setiap 1000 kelahiran hidup. Hiperbilirubinemia merupakan salah satu penyebab terbesar kematian bayi di Indonesia. Peningkatan kadar bilirubin dalam darah bayi dapat mengakibatkan berbagai dampak pada bayi yaitu gangguan pendengaran sensori, gangguan general movement, delay speech disertai dengan gangguan pendengaran, bilirubin enselopati, gangguan reflek moro, opistotonus, vomitus, dan kematian bayi. Pada umumnya, hyperbilirubinemia diprediksi oleh tenaga kesehatan dengan pemeriksaan fisik warna kulit dan sklera pada bayi baru lahir. Pemeriksaan fisik oleh tenaga kesehatan memiliki subjektifitas yang tinggi, dipengaruhi oleh pengalaman, dan memungkinkan adanya bias. Metode pemeriksaan kadar bilirubin di Rumah Sakit yang akurat membutuhkan alat yang mahal, tenaga terlatih, reagen yang mahal, dan tidak tersedia di semua Puskesmas. Padahal era BPJS mensyaratkan persalinan tanpa penyulit dilakukan di fasilitas kesehatan tingkat 1 (Puskesmas/klinik bidan). Permasalahan pemeriksaan bilirubin yang subyektif tersebut merangsang para peneliti untuk mengembangkan metode baru agar pemeriksaan fisik pada bayi yang mengalami hyperbilirubinemia bisa memberikan hasil yang lebih akurat, obyektif, murah, dan mudah dilakukan. Metode kolorimetri telah lama dikenal dalam bidang biosensor namun masih jarang digunakan oleh tenaga kesehatan. Metode ini berdasarkan prinsip utama perubahan warna yang dapat digunakan sebagai suatu cara untuk deteksi dini kondisi pasien. Secara visual, bayi dengan hiperbilirubinemia terlihat dari warna kulit dan sklera yang lebih kuning dari bayi dengan kadar bilirubin normal, namun demikian, pengamatan tersebut tidak dapat digunakan secara kuantitatif untuk memprediksi kadar bilirubin darah. Penelitian ini akan mengembangkan aplikasi berbasis android untuk menilai derajat hyperbilirubinemia melalui warna yang muncul pada permukaan kulit dan sklera bayi. Aplikasi berbasis android ini akan sangat bermanfaat untuk tenaga kesehatan dengan fasilitas laboratorium terbatas atau di daerah terdepan, terluar, dan tertinggal di Indonesia. Tujuan penelitian ini pada tahun I adalah mengembangkan aplikasi berbasis android untuk deteksi dini hiperbilirubinemia pada bayi baru lahir. Pada Tahun II, penelitian ini bertujuan untuk uji validitas dan reliabilitas metode prediksi kadar bilirubin berbasiskan aplikasi berbasis android untuk deteksi dini hiperbilirubinemia pada bayi baru lahir pada berbagai daerah di Indonesia. Hasil penelitian di tahun pertama ini telah mengumpulkan data gambar dahi, tangan, dada bayi yang mengalami hiperbilirubinemia serta data kadar bilirubin bayi yang ada di rekam medis RS. Data kemudian dianalisa dengan ImageJ ver. 1.52k. Hasil penelitian menunjukkan intensitas warna gambar neonates (dahi, tangan maupun dada) memiliki hubungan linier dengan konsentrasi bilirubin darah pasien. Intensitas warna RGB neonatus menunjukkan bahwa intensitas warna biru memiliki hubungan paling tinggi dengan koefisien determinan R2 = 0,832. Content validity dilakukan terhadap tiga expert dan mendapatkan hasil terdapat materi yang tidak relevan dengan isi aplikasi, yaitu patofisiologi bayi kuning dimana menurut expert hal tersebut tidak terlalu penting bagi orang tua bayi. Selain itu juga expert memberikan saran pengganti istilah medis yang krang dipahami oleh orang awam agar lebih mudah dipelajari. Uji keterbacaan dilakukan terhadap 15 ibu yang memiliki bayi baru lahir dan menunjukkan bahwa tampilan aplikasi sudah baik, informasi mudah dipahami, kamera mudah digunakan serta aplikasi mudah diinstal. Masukan untuk pengembangan aplikasi selanjutnya adalah ukuran dan jenis huruf yang lebih nyaman untuk dibaca oleh orang tua serta masih ada istilah yang belum dipahami sehingga perlu diberi keterangan lebih lanjut di aplikasi.

Luaran yang ditargetkan adalah publikasi di prosiding seminar terindex Scopus, dan HKI software. TKT pada penelitian ini adalah skala 2 pada tahun pertama dan skala 3 pada tahun kedua.

B. KATA KUNCI: Tuliskan maksimal 5 kata kunci.

Aplikasi; bayi baru lahir; deteksi dini; hyperbilirubinemia

Pengisian poin C sampai dengan poin H mengikuti template berikut dan tidak dibatasi jumlah kata atau halaman namun disarankan seringkas mungkin. Dilarang menghapus/memodifikasi template ataupun menghapus penjelasan di setiap poin.

C. **HASIL PELAKSANAAN PENELITIAN:** Tuliskan secara ringkas hasil pelaksanaan penelitian yang telah dicapai sesuai tahun pelaksanaan penelitian. Penyajian dapat berupa data, hasil analisis, dan capaian luaran (wajib dan atau tambahan). Seluruh hasil atau capaian yang dilaporkan harus berkaitan dengan tahapan pelaksanaan penelitian sebagaimana direncanakan pada proposal. Penyajian data dapat berupa gambar, tabel, grafik, dan sejenisnya, serta analisis didukung dengan sumber pustaka primer yang relevan dan terkini.

Hasil penelitian pada tahun pertama adalah sebagai berikut:

a. Pengambilan citra digital bayi hiperbilirubinemia

Pengambilan citra digital dilakukan dengan menggunakan smartphone (Redmi, kamera 13MP, f/2.0, PDAF) dengan pencahayaan yang cukup tanpa menggunakan flash kamera. Warna standar disiapkan sebagai pembanding untuk koreksi hasil citra digital dari kemungkinan pengaruh warna lampu maupun cahaya yang kurang. Foto diambil pada jarak sekitar 50cm dan dilakukan pengulangan 3 kali.

Partisipan penelitian telah dikonfirmasi (ibu bayi) dan menyetujui pengambilan gambar neonatus menggunakan smartphone. Pembantu peneliti juga terlebih dahulu menjelaskan deskripsi dan tujuan penelitian ini. Tidak ada paksaan untuk menjadi responden dalam penelitian ini. Pengambilan gambar dapat dilakukan berulang-ulang untuk mendapatkan kondisi pencahayaan dan posisi neonatus yang terbaik.

Bagian-bagian tertentu bayi difokuskan karena beberapa penelitian ada yang menggunakan foto dada, tangan, kelopak mata maupun dahi. Hasil pengambilan foto bayi seperti pada gambar berikut:

A B C

Gambar 1. Foto bayi hiperbilirubinemia ketika difokuskan untuk mengolah data pada bagian dahi (A), tangan (B) dan dada (C).

Gambar neonatus (dahi, tangan ataupun dada) dipindahkan dari smartphone ke laptop (MacBook Air, Apple Inc.) tanpa modifikasi atau penyesuaian apa pun. Gambar digital kemudian dianalisis menggunakan perangkat lunak ImageJ ver. 1.52k (Institut Kesehatan Nasional, AS. http://imagej.nih.gov/ij). Gambar diekstraksi dengan intensitas warna Merah, Hijau dan Biru (RGB) hanya dengan mengarahkan mouse laptop ke dahi gambar neonatus. Tiga lokasi perbedaan telah dicatat untuk intensitas RGB mereka. Bagan warna standar digunakan untuk mengoreksi gambar.

Gambar bayi kemudian dikumpulkan kemudian dianalisis. Bagan warna standar digunakan untuk mengoreksi citra dengan menambah atau mengurangi intensitas warna, apabila nilai intensitas warna putih dan kuning berbeda nyata (lebih dari 3 poin) dengan citra lainnya. Intensitas warna rata-rata warna putih standar pada citra yang diambil adalah R = 201,5, G = 237,5 dan B = 239. Sedangkan rata-rata intensitas warna bagan warna standar kuning adalah R = 202, G = 200,7 dan B = 0,8. Berbagai metode telah dilaporkan untuk mengoreksi pemrosesan citra digital seperti penggunaan kertas putih [10], *white balance* berbasis perangkat lunak [16], *white balance* berbasis label merah [17] dan bagan warna standar [14]. Penggunaan bagan warna standar dalam penelitian ini dilakukan untuk memudahkan

perbandingan dengan berbagai warna untuk pengembangan perangkat lunak smartphone lebih lanjut dimana semua warna standar tersedia dalam sampel gambar.

b. Pengambilan data pendukung

Ikterus neonatorum merupakan kejadian yang umum terjadi pada minggu pertama kelahiran [18] dan merupakan penyebab umum rawat inap neonatus. Ketidakseimbangan antara metabolisme bilirubin menyebabkan peningkatan konsentrasi bilirubin darah. Ketidakseimbangan metabolisme ini disebabkan oleh hati yang belum matang untuk pemecahan sel darah merah yang cepat karena beberapa faktor [19]. Usia kehamilan adalah salah satu dari beberapa faktor yang berhubungan dengan ikterus neonatorum [19]. Usia kehamilan <39 minggu menunjukkan sedikit peningkatan kejadian ikterus[20]. Partisipan penelitian ini menunjukkan bahwa rata-rata usia kehamilan adalah 37,8 minggu, dengan minimal 31 minggu dan maksimal 41 minggu. Induksi persalinan juga dilaporkan sedikit meningkatkan kejadian ikterus neonatorum [20]. Hasil analisis data pada partisipan menunjukkan 43,5% neonatus dari persalinan induksi. Data pendukung selengkapnya dapat dilihat pada tabel 1 dibawah ini.

Tabel 1. Data pendukung responden

No	Kadar bilirubin total (mg/dl)	Jenis kelamin bayi	Berat badan lahir (gram)	Sepsis	Trauma saat persalinan	Distres pernafasan/asfiksi/ RDS	Gangguan konginetal	Kuning mulai hari ke-	Usia (tahun)	Paritas	Pendidikan	P
1	11.9	Laki-laki	1700	Ya	Tidak	Ya	Tidak	9	32	Multipara	SMP	II
2	16.9	Laki-laki	3200	Ya	Tidak	Ya	Tidak	4	25	Multipara	SMP	II
3	11.2	Laki-laki	2698	Tidak	Tidak	Ya	Tidak	26	32	Multipara	SMP	II
4	11.1	Laki-laki	3530	Tidak	Tidak	Tidak	Tidak	2	37	Multipara	S1	D
5	24.5	Laki-laki	1900	Tidak	Tidak	Tidak	Tidak	12	27	Multipara	SMP	II
6	17.7	Perempuan	2450	Tidak	Tidak	Tidak	Tidak	4	36	Multipara	SMP	D
7	22.5	Laki-laki	3000	Tidak	Tidak	Tidak	Tidak	8	37	Multipara	D3	P
8	19.12	Perempuan	2400	Tidak	Tidak	Tidak	Tidak	14	41	Multipara	SD	II
9	19.12	Perempuan	3100	Tidak	Tidak	Tidak	Tidak	8	37	Multipara	SD	II
10	14.1	Laki-laki	3400	Tidak	Tidak	Ya	Tidak	6	25	Multipara	SMA	II
11	19.3	Perempuan	2664	Tidak	Tidak	Tidak	Tidak	4	32	Multipara	SD	II
12	11.67	Perempuan	3020	Tidak	Tidak	Tidak	Tidak	2	29	Multipara	SMP	S
13	11.67	Perempuan	3098	Tidak	Tidak	Tidak	Tidak	2	38	Multipara	SMP	S
14	25.9	Laki-laki	3110	Tidak	Tidak	Ya	Tidak	3	29	Multipara	SD	S
15	13.5	Perempuan	2260	Tidak	Tidak	Tidak	Tidak	4	37	Multipara	SMP	S
16	15.9	Perempuan	3400	Tidak	Tidak	Tidak	Tidak	10	27	Multipara	SMA	S
17	25.17	Perempuan	3605	Tidak	Tidak	Tidak	Tidak	7	26	Primipara	SMA	S
18	19.2	Laki-laki	3138	Tidak	Tidak	Tidak	Tidak	3	19	Primipara	SMP	S
19	19.5	Laki-laki	2700	Tidak	Tidak	Tidak	Tidak	10	38	Multipara	SD	II
20	11.21	Perempuan	2500	Tidak	Tidak	Tidak	Tidak	12	24	Primipara	SMP	S
21	15.1	Laki-laki	3126	Tidak	Tidak	Tidak	Tidak	4	30	Multipara	SMP	II
22	15.5	Perempuan	2380	Tidak	Tidak	Ya	Tidak	5	37	Multipara	SMP	II
23	14	Perempuan	2410	Tidak	Tidak	Tidak	Tidak	4	28	Multipara	SMP	II
24	14	Perempuan	2330	Tidak	Tidak	Tidak	Tidak	4	28	Multipara	SMP	II
25	20.33	Laki-laki	3900	Tidak	Tidak	Tidak	Tidak	8	25	Multipara	SMA	S
26	23.06	Perempuan	3000	Tidak	Tidak	Tidak	Tidak	12	36	Multipara	SMP	II
27	16.27	Perempuan	2500	Tidak	Tidak	Tidak	Tidak	11	24	Multipara	SMA	S
28	11	Perempuan	1526	Tidak	Tidak	Tidak	Tidak	2	37	Multipara	SMP	II
29	19	Perempuan	3354	Tidak	Tidak	Tidak	Tidak	8	38	Multipara	SMP	II
30	16.4	Perempuan	2700	Tidak	Tidak	Ya	Tidak	6	39	Multipara	SMP	II
31	12.2	Perempuan	2005	Tidak	Tidak	Tidak	Tidak	4	37	Multipara	SMA	II
32	13.5	Perempuan	2260	Tidak	Tidak	Tidak	Tidak	4	37	Multipara	SMP	S

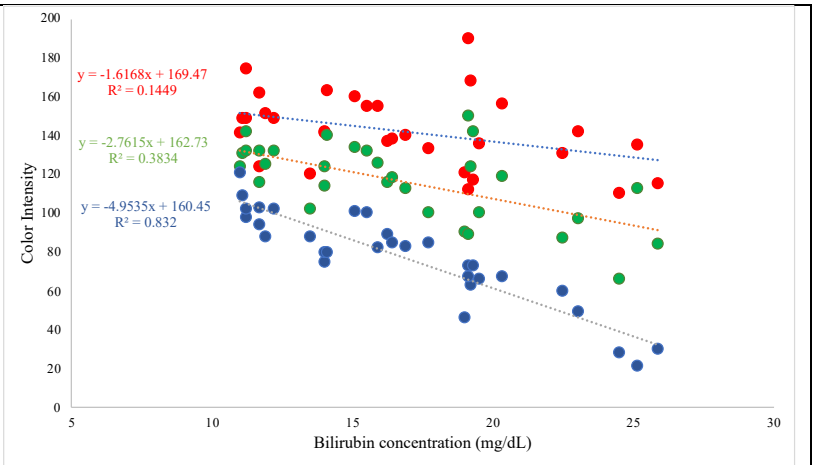
c. Pengolahan data

Intensitas warna gambar neonates (dahi, tangan maupun dada) menunjukkan hubungan linier antara intensitas warna dan konsentrasi bilirubin darah pasien. Intensitas warna RGB neonatus menunjukkan bahwa intensitas warna biru memiliki hubungan paling tinggi (Gambar 2). Intensitas warna gambar dahi neonatus menunjukkan hubungan linier antara gambar dahi dan konsentrasi bilirubin darah peserta. Intensitas warna RGB dahi neonatus menunjukkan bahwa intensitas warna biru memiliki hubungan paling tinggi dengan koefisien determinan R^2 = 0,832. Ada hubungan linier intensitas warna gambar tangan bayi baru lahir dan konsentrasi bilirubin darah peserta yang diperoleh dengan prosedur standar rumah sakit (metode spektrofotometri). Foto tangan yang mengandung intensitas warna merah, hijau dan biru dengan intensitas warna biru menunjukkan hubungan paling tinggi (R^2 = 0,8081) dengan bilirubin darah. Sedangkan intensitas warna gambar dada bayi baru lahir diplot ke konsentrasi bilirubin darah yang sesuai. Di antara intensitas warna merah, hijau dan biru, warna biru menunjukkan sensitivitas dan korelasi terbaik (koefisien determinasi tertinggi) dibandingkan dengan intensitas warna merah dan hijau dengan koefisien determinasi sebesar 0.8505. Oleh karena itu, gambar dada paling kuning, intensitas warna biru terendah, konsentrasi bilirubin tertinggi yang sesuai

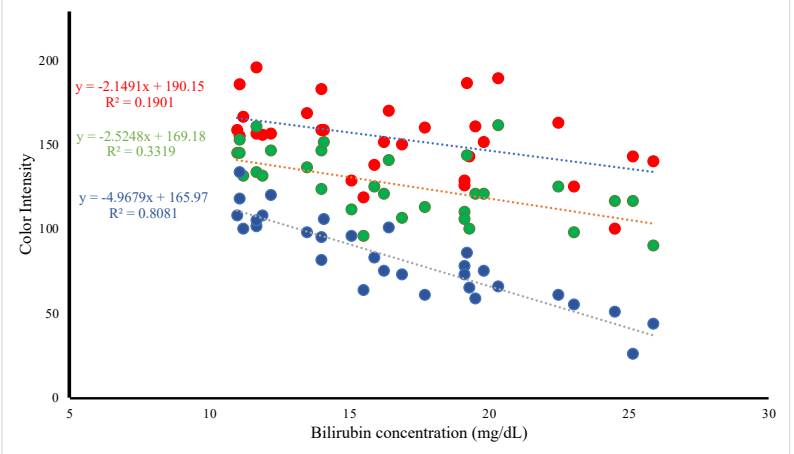
Intensitas warna biru menunjukkan hubungan yang paling tinggi antara intensitas warna dengan konsentrasi bilirubin dibandingkan dengan intensitas warna merah dan hijau. Hubungan terendah adalah intensitas warna merah; oleh karena itu, kulit paling kuning mewakili intensitas warna biru terendah dan konsentrasi bilirubin darah tertinggi. Intensitas bagan warna standar warna kuning juga menunjukkan nilai RGB sekitar merah 200, hijau 200 dan biru 0.

Ketiga bagian tubuh bayi yaitu dahi, tangan dan dada menunjukkan korelasi positif dengan kadar bilirubin darah bayi dengan hiperbilirubin tersebut. Namun demikian, jika dilihat dari koefisien determinasinya, gambar dada bayi menunjukkan angka tertinggi dibandingkan dengan gambar dahi dan tangan. Namun apabila kita melihat sensitivitasnya dari slope/kemiringan kurva garis regresi, maka gambar tangan bayi memiliki sensitivitas tertinggi dibandingkan dengan gambar dahi dan dada bayi yang diamati.

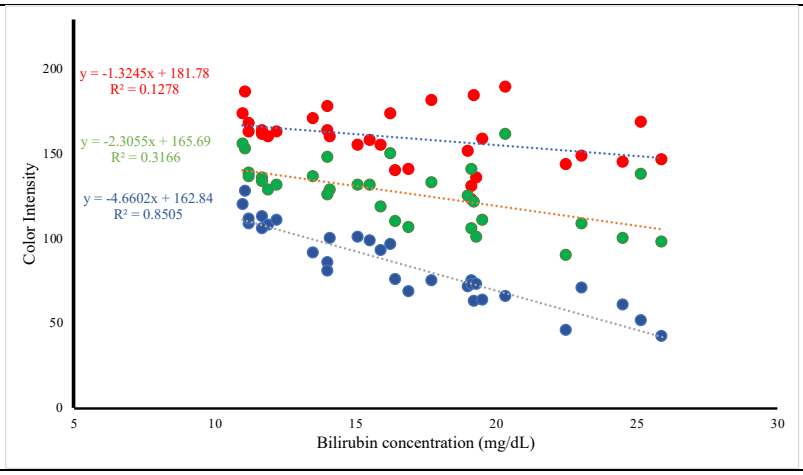
A



B



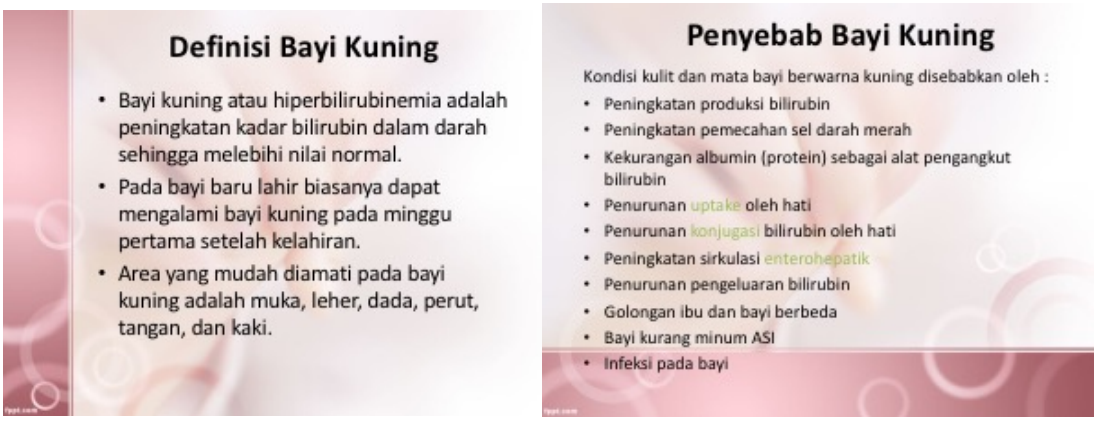
C



Gambar 2. Hubungan intensitas warna dahi (A), tangan (B) dan dada (C) bayi dengan kadar bilirubin darah yang diukur dengan metode laboratorium rumah sakit

d. Perancangan software

Software dirancang untuk dapat mengambil foto bayi dan memprediksi kadar bilirubin dari persamaan garis yang diperoleh pada penelitian ini. Salain itu, software juga memuat informasi seputar hiperbilirubinemia. Contoh informasi yang akan disampaikan dalam software deteksi bilirubin seperti pada Gambar 4



Gambar 4. Rancangan isi software deteksi dini bayi kuning (Dianing)

Content validity dilakukan terhadap tiga expert dan mendapatkan hasil terdapat materi yang tidak relevan dengan isi aplikasi, yaitu patofisiologi bayi kuning dimana menurut expert hal tersebut tidak terlalu penting bagi orang tua bayi. Selain itu juga expert memberikan saran pengganti istilah medis yang krang dipahami oleh orang awam agar lebih mudah dipelajari. Uji keterbacaan dilakukan terhadap 15 ibu yang memiliki bayi baru lahir dan menunjukkan bahwa tampilan aplikasi sudah baik, informasi mudah dipahami, kamera mudah digunakan serta aplikasi mudah diinstal. Masukan untuk pengembangan aplikasi selanjutnya adalah ukuran dan jenis huruf yang lebih nyaman untuk dibaca oleh orang tua serta masih ada istilah yang belum dipahami sehingga perlu diberi keterangan lebih lanjut di aplikasi.

D. **STATUS LUARAN**: Tuliskan jenis, identitas dan status ketercapaian setiap luaran wajib dan luaran tambahan (jika ada) yang dijanjikan pada tahun pelaksanaan penelitian. Jenis luaran dapat berupa publikasi, perolehan kekayaan intelektual, hasil pengujian atau luaran lainnya yang telah dijanjikan pada proposal. Uraian status luaran harus didukung dengan bukti kemajuan ketercapaian luaran sesuai dengan luaran yang dijanjikan. Lengkapi isian jenis luaran yang dijanjikan serta mengunggah bukti dokumen ketercapaian luaran wajib dan luaran tambahan melalui Simlitabmas mengikuti format sebagaimana terlihat pada bagian isian luaran

Peneliti telah mengikuti dua seminar internasional yaitu Internasional Conference of Multidiciplinary Approach for Sustainability in Rural Area (ICMA-SURE) 2021 dan Join Chemistry Conference (JCC) 2021 yang menerbitkan prosiding seminar terindex Scopus. Peneliti telah mengirim satu artikel di ICMA-SURE 2021dan dua artikel di JCC 2021. Artikel sudah direvisi oleh peneliti sesuai dengan hasil review oleh reviewer dan saat ini artikel sudah disubmit ke IOP. Peneliti masih menunggu jawaban artikel diterima atau ditolak oleh editor IOP.

E. **PERAN MITRA:** Tuliskan realisasi kerjasama dan kontribusi Mitra baik *in-kind* maupun *in-cash* (jika ada). Bukti pendukung realisasi kerjasama dan realisasi kontribusi mitra dilaporkan sesuai dengan kondisi yang sebenarnya. Bukti dokumen realisasi kerjasama dengan Mitra diunggah melalui Simlitabmas mengikuti format sebagaimana terlihat pada bagian isian mitra

Pada penelitian ini tidak melibatkan mitra.

F. **KENDALA PELAKSANAAN PENELITIAN**: Tuliskan kesulitan atau hambatan yang dihadapi selama melakukan penelitian dan mencapai luaran yang dijanjikan, termasuk penjelasan jika pelaksanaan penelitian dan luaran penelitian tidak sesuai dengan yang direncanakan atau dijanjikan.

Kendala yang dialami oleh peneliti selama proses pengambilan data situasi pandemi Covid-19 di Indonesia sedang sangat tinggi sehingga pihak RS mengeluarkan kebijakan larangan pengambilan data penelitian di RS untuk meminimalkan transmisi Covid-19 di RS terutama pada kelompok rentan, diantaranya adalah bayi baru lahir. Hasil diskusi antara peneliti dengan pihak RS mendapatkan hasil

enumerator/pengambil data penelitian adalah perawat RS yang telah diberi penjelasan terkait kriteria inklusi, kriteria eksklusi, gform data data karakteristik bayi, pengisin informed consent oleh orang tua bayi, dan teknis pengambilan data dalam penelitian. Proses pengambilan data dilakukan secara bertahap agar data yang diambil bisa dievaluasi terlebih dahulu kesesuainnya dengan rencana penelitian atau tidak. Selanjutnya peneliti dan enumerator mendiskusikan perbaikan pada proses pengambilan data selanjutnya. Hal ini menyebabkan penelitian membutuhkan waktu lebih lama dalam proses pengambilan data.

G. **RENCANA TINDAK LANJUT PENELITIAN:** Tuliskan dan uraikan rencana tindaklanjut penelitian selanjutnya dengan melihat hasil penelitian yang telah diperoleh. Jika ada target yang belum diselesaikan pada akhir tahun pelaksanaan penelitian, pada bagian ini dapat dituliskan rencana penyelesaian target yang belum tercapai tersebut.

Tahapan penelitian yang sedang dalam proses adalah melakukan perbaikan aplikasi DIANING sesuai dengan masukan expert dan responden agar lebih mudah dipahami oleh orang awam. Peneliti juga masih perlu melakukan follow up publikasi artikel di prosiding terindex Scopus ke panitia seminar internasional. Selanjutnya peneliti akan menguji efektivitas aplikasi DIANING kepada ibu yang memiliki bayi kuning dengan metode penelitian Randomized Control Trial di tahun kedua.

H. DAFTAR PUSTAKA: Penyusunan Daftar Pustaka berdasarkan sistem nomor sesuai dengan urutan pengutipan. Hanya pustaka yang disitasi pada laporan akhir yang dicantumkan dalam Daftar Pustaka.

1. Word Health Organization., 2017. World health statistics 2015: World Health Organization.
2. Kementrian Kesehatan Republik Indonesia., 2017. Profil kesehatan Indonesia tahun 2015. Kemenkes RI: Jakarta.
3. Utami, T., 2013. Kejadian Hiperbilirubinemia pada Neonatus di RSUD Prof. Dr. Margono Soekardjo Purwokerto Tahun 2012. Viva Medika, Vol 06, No 11, p.26-31.
4. Raditya, E.R., 2015, Peran Hiperbilirubinemia terhadap kejadian gangguan pendengaran sensori pada bayi. Thesis, Universitas Gadjah Mada, Yogyakarta.
5. Pattinama, P. A., Putranti, A. H., Sarosa, G. I., 2012, General movements pada bayi dengan riwayat hiperbilirubinemia, Sari Pediatri, Vol.14, No.2, p.122-129.
6. Sari, S.N.L., Memy, Y.D., Ghanie, A. 2015, Angka Kejadian Delay Speech disertai gangguan pendengaran pada anak yang menjalani pemeriksaan pendengaran di bagian neurologi IKHT-KL RSUP Dr.Moh.Hoesin, Jurnal Kedokteran dan Kesehatan, Vol.2, No.1, p121-127.
7. Juffrie, M., Soenarto, S.S.Y., Oswari, H., Arief, S., Rosalina, I., Mulyani, N.S., 2012, Buku ajar gastroenterologi-hepatologi, Jilid 1, Jakarta: Badan Penerbit IDAI.
8. Anggraeni, M.D, & Fatoni, A., 2016, Non-invasive self care anemia detection during pregnancy using a smartphone camera, IOP conference series: Material science and engineering, vol.172, conference 1.
9. Wallenstein, M.B., Bhutani, V.K. 2013. Jaundice and Kernicterus in the Moderately Preterm Infant. Vol. 40, Clinics in Perinatology. p. 679–88.
10. Bhutani, V.K., Zipursky, A., Blencowe, H., Khanna, R., Sgro, M., Ebbesen, F., et al. 2013. Neonatal hyperbilirubinemia and Rhesus disease of the newborn: incidence and impairment estimates for 2010 at regional and global levels. Pediatr Res [Internet], 74 Suppl 1(December):86–100. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3873706&tool=pmcentrez&rendertype=abstract
11. Olusanya, B.O., Osibanjo, F.B., & Slusher, T.M., 2015, Risk factors for severe neonatal hyperbilirubinemia in low and middle-income countries: A systematic review and meta-analysis. PLoS One;10(2).
12. Muchowski, K.E. 2014, Evaluation and treatment of neonatal hyperbilirubinemia. Am Fam Physician. 89(11):873–8.
13. Anggraeni, M.D., Aji, B., Setiyani, R., Kartikasari, A., & Rahmawati E. 2018, How do modern parents deal with cultural beliefs about breastfeeding? A qualitative study. Br J Midwifery, Vol. 26, No. 9.

14. Rahmawati, E., Susmarini, D., Lestari, P., Putri, A.D. 2019, Physical Stimulation For Hiperbilirubin. IOP Conf Ser Earth Environ Sci.
15. Kramer, L.L., 1969, Advancement of dermal icterus in the Jaundice Newborn, American Journal of Disease Children, 118(3), 454-458.
16. Kyle, T., & Carman, S. 2015, Essentials of pediatric nursing: Third edition [Internet]. Essentials of Pediatric Nursing: Third Edition. 1-1232 p. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84973121377&partnerID=40&md5=11e0e32cd38de915ce098599f6f9b6cc
17. Yatin, Verma, D. 2015 Neonatal Jaundice. YUVA J Med Sci. Vol. 2, No.4.
18. Botelho, B.G., de Assis, L.P., & Sena, M.M. 2014. Development and analytical validation of a simple multivariate calibration method using digital scanner images for sunset yellow determination in soft beverages. Food Chemistry, 159: 175-180.
19. Kohl, S.K., Landmark, J.D., & Stickle, D.F. 2006. Demonstration of Absorbance Using Digital Color Image Analysis and Colored Solutions. Journal of Chemical Education, 83: 644.
20. Lima, M.B., Andrade, S.I.E., Barreto, I.S., et al. 2013, A digital image-based micro-flow-batch analyzer. Microchemical Journal, 106: 238-243.

Dokumen pendukung luaran Wajib #1

Luaran dijanjikan: Artikel pada Conference/Seminar Internasional di Pengindeks Bereputasi

Target: Terbit dalam Prosiding
Dicapai: Submited

Dokumen wajib diunggah:
1. Naskah artikel
2. Bukti submit

Dokumen sudah diunggah:
1. Naskah artikel
2. Bukti submit

Dokumen belum diunggah:
- Sudah lengkap

Peran penulis: first author
Nama Konferensi/Seminar: The 16th Joint Conference on Chemistry 2021
Lembaga penyelenggara: Jurusan Kimia, Universitas Jenderal Soedirman
Tempat penyelenggara: Purwokerto
Tgl penyelenggaraan mulai: 9 September 2021 | Tgl selesai: 10 September 2021
Lembaga pengindeks: Scopus
URL website: https://conference.unsoed.ac.id/index.php/JCC16/JCC16
Judul artikel: Non-invasive Neonatal Jaundice Determination using Smartphone Camera

Non-invasive Neonatal Jaundice Determination using Smartphone Camera

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Abstract. Neonatal jaundice is one of the common clinical conditions where the bilirubin levels are above the normal condition, which needs medical attention. It is important to the early determination of neonatal jaundice, especially in a rural area with limitations of medical instruments for bilirubin determination. This research was performed to determine neonatal jaundice using a smartphone camera. The smartphone was used to capture the arm of the neonatal. The arm images were then analyzed using ImageJ software to extract the color intensity of red, green and blue (RGB). The color intensity and the blood bilirubin concentration of neonatal were analyzed to obtain the linear regression. The results showed the blue (B) color intensity had a high correlation (R2 = 0.8081, y= -4.968x + 165.97) with blood bilirubin concentration of neonatal observed. This study showed an important aspect of the use of smartphone camera for early detection of neonatal jaundice as an alternative of the visual assessment mainly in remote area when the laboratories analysis is not immediately available.

INTRODUCTION

Neonatal jaundice is commonly found in newborn infants and commonly a reason for hospitalization. In the first week of life, about 60 to 80% of newborn infants develop jaundice, shown in yellow discoloration of the skin and sclera [1]. In Indonesia, almost 48% of newborns showed hyperbilirubinemia [2]. Hyperbilirubinemia is one of the contributors to the high Infant Mortality Rate (IMR) in Indonesia [3]. The IMR in Indonesia is very high at 26.9/1000 live birth and that of the highest IMR in southeast Asia.

Various methods have been reported to determine the blood bilirubin concentration in the newborn infants, for the invasive [4] and non-invasive methods [5]. Bilirubin is neurotoxic to the newborn infants. Hyperbilirubinemia would be caused the deposition of bilirubin in the basal ganglia, resulting in kernicterus [5]. Other effects of hyperbilirubinemia in infants including loss of hearing [6], general movement disorders [7], speech delay with hearing loss [8], bilirubin encephalopathy, moro reflex disorders, opisthotonos, vomiting, and death. Long-term manifestations of hyperbilirubinemia in infants are spasticity, choreoathetosis, and sensorineural deafness [9].

Bilirubin monitoring and phototherapy have been significantly reducing the effect of hyperbilirubinemia in infants [10]. However, in developing country IMR is still high due to the lack of access to medical equipment, especially for the remote areas or rural areas. Hyperbilirubinemia is easily characterized by the yellow color of the skin and sclera. The skin yellow color as an indicator of an increase in bilirubin levels could be observed through physical examination in infants by expert medical care [11]. The physical examination of visual inspection could be inaccurate and it is highly subjective, dependent on experience, and may give inaccurate results [12]. On another side, the laboratory

protocol using instruments such as spectrophotometer to determine the blood bilirubin concentration provides accurate results. However, the equipment and reagents are relatively expensive, requires special expertise, and it is not available in a remote area. A new method is needed to determine the newborn bilirubin concentration for neonatal jaundice monitoring at a portable, low cost, providing good results. accurate, real-time and easy to use.

Smartphones have been reported to be used as analytical devices, replace conventional visual observation. The methods of the use of smartphone cameras such as to predict the hemoglobin level [13], food safety[14], iron in water [15] and also and glucose[16]. The basic principle of the use of a smartphone camera for analytical device is the digital image capturing of the object, extracting the color and analyzing the color intensity relative to the targeted analytes. The neonatal jaundice prediction using a smartphone could be used to replace the conventional method of a visual examination of skin and sclera [11]. This work reports the use of a smartphone camera to capture the arm of infants with bilirubinemia during hospitalization of neonatal jaundice. The images were then analyzed and related to the blood bilirubin obtained by the hospital protocol to get the equation further used to predict the neonatal jaundice.

METHOD

Study design

Respondent of 31 newborns have been asked for participating the research with criteria of newborn had jaundice and hospitalized. The informed consent has been explained to his/him mothers by the research assistant, and then signed my mother's when agree to participate in this research. The participants have been collected from a local district hospital with the inclusion criteria of newborn showed symptoms of hyperbilirubinemia and need hospitalization. The newborn image was captured in their hospital ward accompanied and with the consent of the newborn's mother. The newborn's blood bilirubin concentration has been analyzed according to the standard method and procedure in the hospital care for neonatal jaundice without any researcher intervention.

Neonatal arm image capturing

Arm images of the participants have been captured using a smartphone camera (Redmi, Camera 13 MP, f/2.0, PDAF) under sufficient lighting without using a camera flash. A standard color chart [17] has been prepared and placed beside the newborn when capturing the images (**Fig. 1**). Image capture was taken for about 50-60 cm distance, with several repetitions to obtain the best images.

Figure 1. Example of neonatal arm image with the standard color chart

Image analysis

Arm images from the smartphone have been analyzed using a laptop (MacBook Air, Apple Inc.) without any treatment or image processing. The images were then extracted to their color intensity of red, green and blue (RGB) using a free software ImageJ software ver. 1.52k (National Institute of Health, USA. http://imagej.nih.gov/ij). Three different spots in the arms image have been analyzed the color intensity to get the representative image sampling site. The standard color chart was used to correct the possible bad lighting and colored light effect.

Data analysis

Newborn arm image color intensity of RGB was collected and analyzed. The standard color chart spot of the white and yellow boxes was also analyzed. The RGB color intensity of the newborn arm was adjusted when the standard color chart showed a significant difference. The newborn blood bilirubin concentration reported in the medical record has also been collected. Arm image color intensity as a dependent variable was then related to the blood bilirubin concentration (as independent variables) using a simple regression equation (Microsoft Excel). The three RGB color intensities were separately analysis and the color with the highest coefficient of determination has been selected as the best color to predict the bilirubin concentration.

RESULTS DAN DISCUSSION

Respondents characteristics

Respondents who agreed to participate in this research was newborn/neonatal with inform consent signed by mothers. The average of mother's ages were 32 years, with a range of 19 to 41 years and 93.5% of mothers were multipara. None of the mothers had a newborn with hyperbilirubinemia in previous birth. The newborns have a range of neonatal jaundice for 2 days from birth to 26 days with the birth weight in the range of 1526 g to 3900 g and a birth weight average of 2761.4 g. The gestational ages of the newborns were 31 to 41 weeks. The blood bilirubin concentrations were 11 to 25.9 mg/dL with an average of 16.6 mg/dL. The neonatal were 69% cesarean birth and the rest natural birth. These participants' data could be important information for further neonatal jaundice profiling and analysis.

Image Capturing

The newborn arm images were captured by a research assistant with the permission of him/his mother (inform consents have been signed by mother). The research assistant was first explained the aim of this research. There is no compulsion to become a respondent in this study. The arm image has been selected since this body part is easy to capture and almost always exposed even the newborn was dressed. Neonatal jaundice initially causes the skin to become yellow, therefore, neonatal jaundice could be easily observed the yellow color mainly showed in the face, chest, stomach area, arms and legs[18]. The arm images were captured several times to get the best images with the clear arm and sufficient light condition. The captured newborn arm images were then analyzed. A standard color chart was used to correct the images by adding or reducing the color intensity. The white and yellow boxes in the color chart was used to correct the light condition and the effect of colored light may exist. The arm images were corrected when the standard color chart of yellow and white had significantly (more than 3 points) different from other images. The average color intensities of standard white color in the captured images were R = 201.5, G = 237.5 and B = 239. Whereas the average color intensities of the yellow standard color chart were R = 202, G = 200.7 and B = 0.8. The use of a standard color chart was also previously used to correct the digital image processing [17]. Many strategies to correct the digital image analysis were also reported such as software white balance correction [19], the use of white paper [13] and red label-based white balance [20]. The use of a standard color chart in this research was selected for further smartphone software development where all standard color box available for analysis.

Data Analysis

There was a linear relationship of newborn arm image color intensity and blood bilirubin concentration of the participants obtained by standard hospital procedures (spectrophotometric method). The arm images contain red, green and blue color intensities with the blue color intensity showed the highest relationship (R^2 = 0.8081) with the blood bilirubin (**Fig. 2**). On another side, the red color intensity showed the lowest relationship. The standard color chart or yellow box also showed the blue color intensity was almost zero, while the red and green colors showed similar intensity (RGB = 200,200,0).

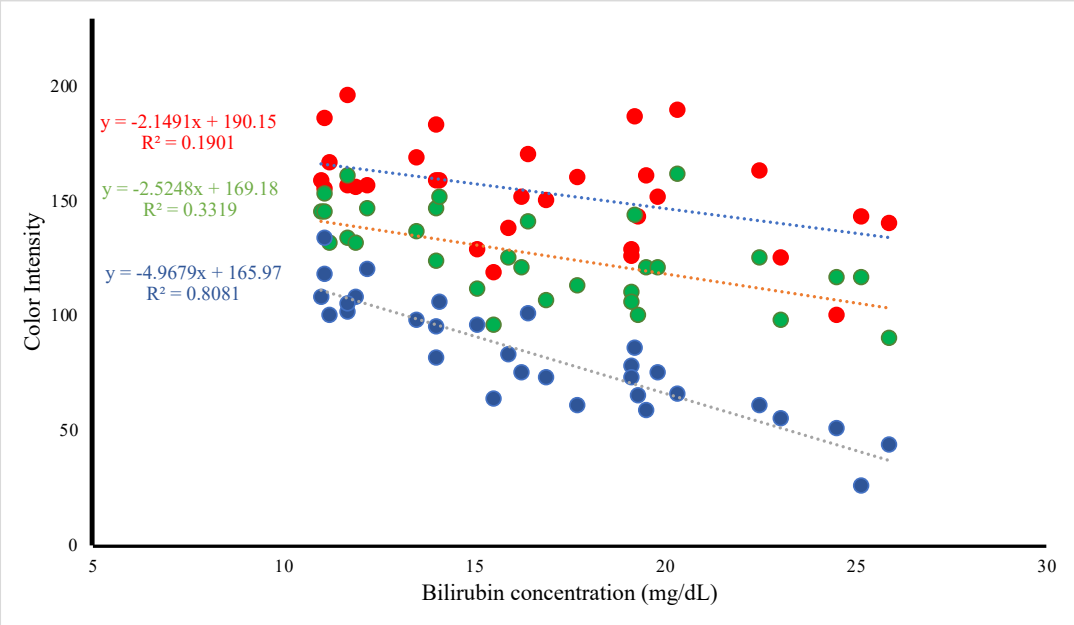

Figure 2. The red, green, and blue color intensity of neonatal arm images relations with blood bilirubin concentration. Blue color intensity showed the best relationship compare to red and green color intensity.

Neonatal jaundice related factors

Excess neonatal blood bilirubin (hyperbilirubinemia) is the main cause of neonatal jaundice. Neonatal jaundice is common cause of hospitalization and commonly occurs in the first week of birth [21]. Bilirubin is responsible for the yellow color of neonatal jaundice, which is a normal part of pigment released from the breakdown of red blood cells. Imbalance the metabolism of rapid red blood cells breakdown by immature liver leads to an increase in the blood bilirubin concentration. A newborn immature liver often failed to remove the bilirubin quickly enough resulted in the excess of bilirubin. The conditions that can cause neonatal jaundice could be several factors [22], such as jaundice observed in the first 24h, premature birth [23], significant bruising during birth, blood type, breastfeeding and race [11]. Premature birth or gestational age of 35-36 weeks was the major risk factor, whereas the gestational age of 37-38 was the minor risk factor of neonatal jaundice [11]. The gestational age for more than 40 weeks showed a decreased risk of neonatal jaundice. The participants of this research showed that the average gestational age was 37.8 weeks, with a minimum of 31 weeks and maximum of 41 weeks. Premature newborns also may feed less and have fewer bowel movements, resulting in less bilirubin eliminated through stool [24]. Induced labor was also reported to slightly increase the neonatal jaundice incidence [23]. The result of data analysis in the participants showed the 43,5% were neonatal from the induced labor.

CONCLUSION

The neonatal jaundice prediction method has been developed using arm images of neonatal captured by a smartphone camera. The blue color intensity of the neonatal arm showed a high correlation with the blood bilirubin concentration performed using the standard method in the hospital. The use of a smartphone to capture neonatal arm images and predict neonatal jaundice would be important as an objective preliminary screening of neonatal jaundice compared to the visual assessment, for the area where hospital instrumentation is not available.

ACKNOWLEDGMENT

We would like to thank the Directorate General of Higher Education (DGHE, DIKTI) and the Jenderal Soedirman University for supporting this research through "Penelitian Dasar Unggulan Perguruan Tinggi" grant no T/1422/UN23.18/PT.01.01/2021.

REFERENCES

1. S. Mitra and J. Rennie, *Br. J. Hosp. Med.* **78**, 699 (2017).
2. T. Utami, *J. Viva Med.* **6**, 26 (2013).
3. Indonesian Ministry of Health, *Profil Kesehatan Indonesia Tahun 2019* (2019).
4. K. Grohmann, M. Roser, B. Rolinski, I. Kadow, C. Müller, A. Goerlach-Graw, M. Nauck, and H. Küster, *Pediatrics* **117**, 1174 (2006).
5. G. Inamori, U. Kamoto, F. Nakamura, Y. Isoda, A. Uozumi, R. Matsuda, M. Shimamura, Y. Okubo, S. Ito, and H. Ota, *Sci. Adv.* **7**, eabe3793 (2021).
6. A.E. Raditya, (2015).
7. P.A. Pattinama, A.H. Putranti, and G.I. Sarosa, *Sari Pediatr.* **14**, 122 (2016).
8. S.N.L. Sari, Y.D. Memy, and A. Ghanie, *J. Kedokt. Dan Kesehat. Publ. Ilm. Fak. Kedokt. Univ. Sriwij.* **2**, 121 (2015).
9. B.O. Olusanya, S. Teeple, and N.J. Kassebaum, *Pediatrics* **141**, (2018).
10. M.W. Kuzniewicz, G.J. Escobar, and T.B. Newman, *Pediatrics* **124**, 1031 (2009).
11. M.J. Maisels, *Pediatr. Rev.* **27**, 443 (2006).
12. V.A. Moyer, C. Ahn, and S. Sneed, *Arch. Pediatr. Adolesc. Med.* **154**, 391 (2000).
13. M.D. Anggraeni and A. Fatoni, in *IOP Conf. Ser. Mater. Sci. Eng.* (2017).
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15. A. Fatoni and M.D. Zusfahair, in *J. Phys. Conf. Ser.* (2020), p. 12030.
16. A. Soni and S.K. Jha, *Anal. Chim. Acta* **996**, 54 (2017).
17. J.C.A. Fernandes, J.A.B.C. Neves, M.J.S. Freitas, and J.L. Afonso, in *2008 IEEE Int. Symp. Ind. Electron.* (IEEE, 2008), pp. 1025–1028.
18. R.J. Wong and V.K. Bhutani, *UpToDate, Available Http//Www. Uptodate. Com/Contents/Jaundice-in-Newborn-Infantsbeyond-the-Basics (Accessed 5 Sept. 2016)* (2016).
19. J.-H. Seo, Y.-B. Park, and Y.-J. Park, *Eur. J. Integr. Med.* **6**, 322 (2014).
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22. S.Y. Mojtahedi, A. Izadi, G. Seirafi, L. Khedmat, and R. Tavakolizadeh, *Open Access Maced. J. Med. Sci.* **6**, 1387 (2018).
23. B. Wood, P. Culley, C. Roginski, J. Powell, and J. Waterhouse, *Arch. Dis. Child.* **54**, 111 (1979).
24. H.D. Buiter, S.S.P. Dijkstra, R.F.M.O. Elferink, P. Bijster, H.A. Woltil, and H.J. Verkade, *Eur. J. Pediatr.* **167**, 501 (2008).

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Judul artikel: Prediction of Bilirubin Concentration using Neonatal Forehead Images

Prediction of Bilirubin Concentration using Neonatal Forehead Images

Mekar Dwi Anggraeni[1, a)], Amin Fatoni[2, b)], and Eni Rahmawati[1, c)]

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Abstract. Neonatal jaundice is one of the most common reasons for hospital admission in the neonatal care unit, which it is associated to significant morbidity and mortality. Neonatal jaundice, indicated with hyper bilirubin in neonatal blood, occur in 60% of >35 weeks neonatal and 80% of <35 weeks neonatal. Therefore, it is important to develop the ease method to predict the hyper bilirubin in neonatal. This study was performed to develop the easy and objective method to determine the bilirubin in neonatal based on the forehead image captured using smartphone camera. Methodology of this research including the capturing of the neonatal forehead with the calibration color chart, followed by analyzing the image using ImageJ software to extract the color intensity of the digital images. The red, green and blue (RGB) colors were then analyzed to find the best correlation between the color intensity of neonatal forehead images with the blood bilirubin concentration. The bilirubin concentration was determined using standard method performed in the hospital based on spectrophotometric method. The smartphone-based methods of neonatal forehead images showed a linear correlation (R2=0.832) between blue color intensity and blood bilirubin concentration of neonatal observed with a regression line of y= -4.954x + 160.45. This result could be used for further self-detection by the mothers of neonatal jaundice or healthcare monitoring mainly in the remote area.

INTRODUCTION

The infant mortality rate (IMR) is one indicator of a country's health status. IMR in Indonesia is the highest in Southeast Asia [1]. IMR in Indonesia is very high at 26.9 per 1000 live births [2]. One of the causes of the high IMR in Indonesia is hyperbilirubinemia in newborns [2]. The results of research conducted by Utami [3] showed that almost (48%) of newborns had hyperbilirubinemia.

Hyperbilirubinemia is a serious health problem. The effects of hyperbilirubinemia in infants are hearing loss [4], general movement disorders [5], speech delay with hearing loss [6], bilirubin encephalopathy, moro reflex disorders, opisthotonos, vomiting, and death. Long-term manifestations of hyperbilirubinemia in infants are spasticity, choreoathetosis, and sensorineural deafness [7].

The clinical manifestation of hyperbilirubinemia is discoloration of the skin and sclera. Yellow color in the skin is an indicator of an increase in bilirubin levels which is known through physical examination in infants [8]. Physical examination through visual inspection provides inaccurate data, is highly subjective, highly dependent on experience, and may give inaccurate results [9]. Laboratory tests performed to assess bilirubin levels in the blood provide accurate results, the cost of equipment is expensive, requires special expertise, and primary health facilities are not always

available. A method is needed that can be used by health workers to assess hyperbilirubinemia in infants without invasive measures, providing good results. accurate, real time, easy, and cheap.

Cellular phones (smartphones) are developing very quickly in the world. The use of smartphone camera for detection methods have been previously reported to predict the hemoglobin level [10], food safety[11], iron in water [12] and also and glucose[13]. Smartphone have the potential to be used as an early detection tool for hyperbilirubinemia in newborns using the basic principle of digital image analysis. The neonatal skin color for hyper bilirubin prediction using smartphone could be used to replace the conventional method of visual examination of the inferior palpebral conjunctiva area [8]. The development of a simple tool for early detection of hyperbilirubinemia in neonatal will increase the objectivity of the examination results. The use of cameras on cell phones for early detection of hyperbilirubinemia in newborns is interested in developing country as a program for reduce the infant mortality rate by early hyperbilirubinemia prediction in neonatal.

METHODS

Study design

Thirty-one neonatal has been ask as participant (inform consent filled by mothers) in the district hospital with the inclusion criteria of neonatal with the hyperbilirubinemia. The images have been captured before and after treatment of the neonatal, therefore a range of bilirubin concentration from normal (after treatment) and hyperbilirubinemia (before treatment) could be collected. The blood bilirubin of the neonatal have been analyzed according to the standard method and timelines in the hospital without any researcher intervention.

Neonatal forehead image capturing

Neonatal forehead images were captured using smartphone camera (Redmi, Camera 13 MP, f/2.0, PDAF) under sufficient lighting without using camera flash. A printed reflective color chart reference[14] has been place besides the neonatal (**Fig. 1**). Photograph of neonatal forehead was taken at a distance about 50-60 cm for 3 times.

Figure 1. Neonatal forehead image capturing with a reflective color chart reference.

Image analysis

Neonatal forehead images were transferred from the smartphone to a laptop (MacBook Air, Apple Inc.) without any treatment or adjusting. The forehead digital images were then analyzed using ImageJ software ver. 1.52k (National

Institute of Health, USA. http://imagej.nih.gov/ij). The images were extracted their color intensity of Red, Green and Blue (RGB) by simple hover the laptop mouse over the forehead of the neonatal images. Three difference location have been recorded for their RGB intensity. The standard color chart has been used to correct the images.

Data analysis

Raw data of RGB color intensity of neonatal forehead were collected. The color intensity was then adjusted according to the white, grey and yellow color of the standard color chart. The bilirubin concentration of blood neonatal reported in the medical record of the neonatal has also been collected. Neonatal forehead color intensities as the dependent variables were then analyzed using simple regression (Microsoft Excel) related to the blood bilirubin concentration as the independent variables. The analysis would result a regression line with the regression equation and coefficient of determination. The three RGB color intensity were separately analysis and the color with the highest coefficient of determination has been selected.

RESULTS DAN DISCUSSION

Study participants

Neonatal participant data have been collected with birth weight of 1526 to 3900 g. The blood bilirubin concentrations were 11 to 25.9 mg/dL with average of 16.6 mg/dL. The age of neonatal mothers were 19 to 41 years with an average of 32 years. The neonatal jaundice symptoms appear from 2 days to 26 days from birth, with average of 6.9 days. The neonatal were 69% cesarean birth and the rest natural birth. The gestational ages were 31 to 41 weeks. These participants data could be important information for further neonatal jaundice profiles.

Neonatal image capturing and processing

Neonatal mothers' participants have been confirmed their approving for neonatal forehead images capturing using a smartphone. The research assistant was also first explained the description and aimed of this research. There is no compulsion to become a respondent in this study. The forehead has been chosen since forehead is one of the most stable sites of neonatal [15] and also it has a large flat surface for easy image analysis. The image capturing could be repeated to get the best lighting condition and neonatal position. The collected forehead images were then analyzed. Standard color chart was used to correct the images by adding or reducing the color intensity, when the value of color intensity of white and yellow color was significantly (more than 3 point) different with another images. The average color intensities of standard white color in the captured images were R = 201.5, G = 237.5 and B = 239. Whereas the average of color intensities of the yellow standard color chart was R = 202, G = 200.7 and B = 0.8. Various methods have been reported to correct the digital image processing such as the use of white paper [10], software based white balance [16], red label based white balance [17] and standard color chart [14]. The use of standard color chart in this research was performed to easy comparison with various color for further smartphone software development where all standard color available in the sample images.

Regression analysis

The neonatal forehead images color intensity showed a linear relationship between forehead image and blood bilirubin concentration of the participants. RGB color intensity of the neonatal forehead showed that the blue color intensity had highest relationship with the coefficient of determinant of $R^2 = 0.832$ (**Fig. 2**). The blue color intensity showed the highest relationship between color intensity and bilirubin concentration compare to red and green color intensity. The lowest relationship was the red color intensity; therefore, the yellowest skin represents the lowest blue color intensity and the highest blood bilirubin concentration. The standard color chart intensity of yellow color also showed the RGB values was about red of 200, green of 200 and blue of 0.

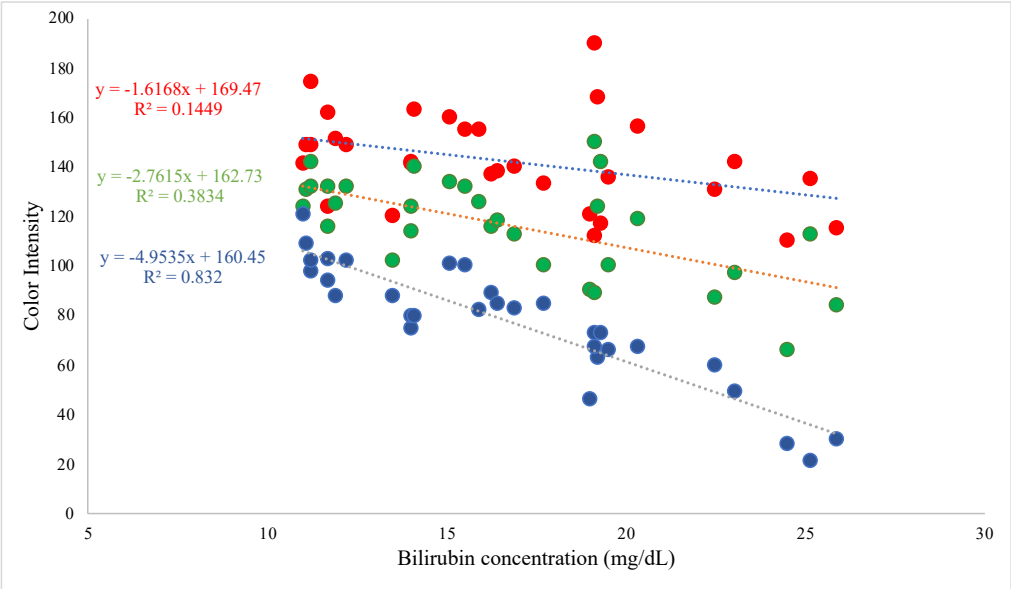

Figure 2. Relationship between neonatal forehead images color intensity and blood bilirubin obtained by hospital laboratory (n=31). Dotted line represents best fit by linear regression.

Factors effecting neonatal jaundice

Neonatal jaundice is common event occur in the first week of birth [18] and it is common causes of the neonatal hospitalization. Imbalance between bilirubin metabolism leads to increase the blood bilirubin concentration. This imbalance of metabolism due to the immature liver for rapid breakdown the red blood cells due to several factors [19]. Gestational age was one of several factors related to neonatal jaundice [19]. Gestational age <39 weeks showed increase the incidence of jaundice [20]. The participants of this research showed that the average of gestational age was 37.8 weeks, with the minimum of 31 weeks and maximum of 41 weeks. Induced labor was also reported slightly increase the neonatal jaundice incidence [21]. The result of data analysis in the participants showed the 43,5% neonatal from the induced labor.

CONCLUSION

The neonatal hyper bilirubin could be predicted using a smartphone camera, with a high correlation between blue color intensity if neonatal forehead images and blood bilirubin concentration. The use of digital image would be useful and more objective than visual observation where the instrumentation not available for neonatal hyper bilirubin detection, especially in the remote area.

ACKNOWLEDGMENT

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REFERENCES

1. World Health Organization, *World Health Statistics 2015* (World Health Organization, 2015).
2. Indonesian Ministry of Health, *Profil Kesehatan Indonesia Tahun 2019* (2019).
3. T. Utami, *J. Viva Med.* **6**, 26 (2013).
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20. S. Mitra and J. Rennie, *Br. J. Hosp. Med.* **78**, 699 (2017).
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Judul artikel: Estimation of Neonatal Jaundice from the chest images captured with a smartphone

Estimation of Neonatal Jaundice from the chest images captured with a smartphone

Mekar Dwi Anggraeni[1, a)], Amin Fatoni[2, b)], Eni Rahmawati[1, c)] and Ismei Nartiningsih[3, d)]

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Abstract. Hyperbilirubinemia is a common problem in neonatal for contact with the healthcare facilities. Several methods have been used to determine the bilirubin concentration. However, it is not easy to find the healthcare with the instrument to detect bilirubin, mainly in rural area. This research was aimed to develop a simple method for neonatal hyperbilirubinemia based on the chest images captured using a smartphone. A total of 31 randomly selected neonatal were studied, with the parental inform consent. The chest images have been capture using smartphone camera with the standard color chart besides the neonatal. The captured images were then analyzed by extracting the color intensity using ImageJ software. The bilirubin concentration obtained using standard method from the hospital were then analyzed to show the association of the chest color intensity with the bilirubin concentration. The result showed a high correlation between the blue color intensity and the blood bilirubin with the regression line of $y = -0.466x + 162.84$ ($R^2 = 0.851$). The result of this study indicated the smartphone camera images of neonatal chest could be used for a simple screening tool of neonatal hyperbilirubinemia. Further study could be performed for smartphone software development of the bilirubin prediction from the neonatal chest images.

INTRODUCTION

Indonesia is one of the country in southeast Asia with the high of infant mortality rate [1] of about 26.9/1000 live birth [2]. One of the causes of the high IMR in Indonesia is hyperbilirubinemia in newborns [2]. About 60% of infant mortality occur in the range of 0-28 days after birth. Neonatal jaundice is one of factors affecting infant mortality rate. The neonatal jaundice is indicated by the high level of blood bilirubin. Almost 48% of neonatal showed hyperbilirubinemia [3].

The hyperbilirubinemia could be detected using standard protocol in the hospital of spectrophotometric method. The hyperbilirubinemia was also could be observed visually in case of spectrophotometric method is not immediately available, indicated by the yellowish color of the skin and sclera [8]. Physical examination needs an expert medical personnel or nurse, could be provides inaccurate data, is highly subjective and may give inaccurate results [9]. In another side, laboratory standard protocol using spectrophotometer provide accurate results of bilirubin determination, but the cost of equipment is expensive, requires special expertise, and primary health facilities are not always available.

An alternative method is needed to determine or predict the neonatal jaundice with a good result, accurate, easy, low cost, portable and available in wide area including rural and remote villages.

Now day, almost everyone has smartphone with camera. The use of camera smartphone as alternative of visual observation or analytic instrumentation have been reported such as hemoglobin prediction [10], food safety[11], iron in water [12] and also and glucose[13]. The principle of using smartphone camera was the digital image had a color intensity and this value could be related to any analytes where the color change with the higher concentration of analytes such as in case of hemoglobin related to red color or hyperbilirubin related to yellow color. The neonatal skin color for hyper bilirubin prediction using smartphone could be used to replace the conventional method of visual examination of the inferior palpebral conjunctiva area [8]. The use of smartphone camera for early detection of hyperbilirubin could be used to improve the conventional method of visual examination. The proposed smartphone camera based observation would help early detection system, especially in developing country where the instrumentation for bilirubin determination is limited.

METHODS

Study design

Participants in this research were 31 newborn infants with hyperbilirubinemia who were hospitalized in the local district hospital. The inform consent as research participant has been signed by mothers. The chest images of the infant have been capturing during hospitalization where the blood bilirubin was also been analyzed by the hospital procedure both before and after treatment of the hyperbilirubinemia. The blood bilirubin has been analyzed without any interference from the researcher. The chest images were capture according to the timeline of the blood bilirubin determination by the hospital.

Newborn infant chest photo shoot

The chest photos have been captured using a smartphone camera (Redmi, Camera 13 MP, f/2.0, PDAF) under sufficient lighting without using camera flash. The photo capturing condition in the care room with white regular room light. A printed standard color chart as references [14] has been prepared and placed besides the newborn infant (**Fig. 1**). The photo capturing was performed at a distance of about 50-60 cm.

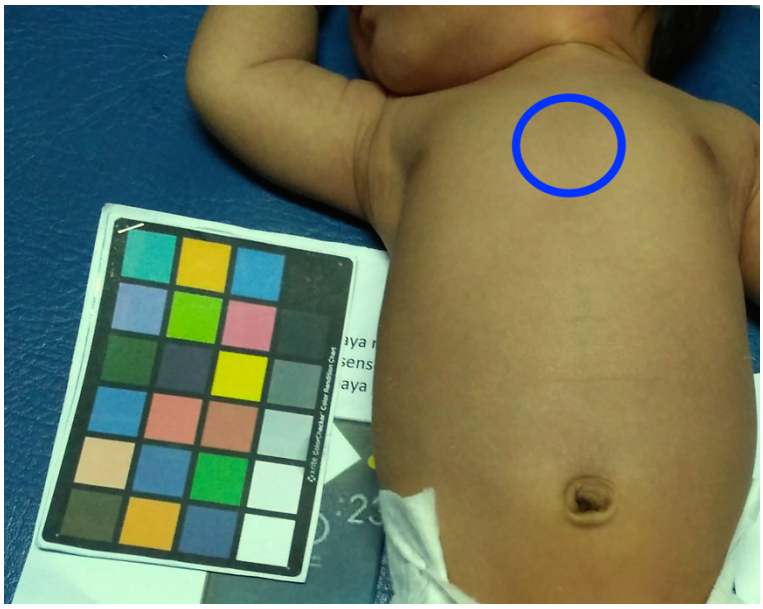

Figure 1. Smartphone camera could be used to predict the newborn blood bilirubin concentration. Observed site was marked in blue circle, standard color chart was prepared for correction.

Image analysis

Collected chest photos (digital images) have been transferred from smartphone to laptop (MacBook Air, Apple Inc.) for further image analysis. No image editing or processing in the smartphone prior to photo transferring. The chest digital images were analyzed using free software of ImageJ (ver. 1.52k, National Institute of Health, USA. http://imagej.nih.gov/ij). The ImageJ software was used to extract the color intensity of chest image into RGB color model to get the intensity of each red, green and blue. The RGB intensity could be record by simple hover the mouse over the chest image or using the line and the available RGB profile plot plugins. Three spots have been recorded their RGB intensity to get the representative sampling. The standard color chart has been used to correct the images from the possible different light condition and colored lamp effect.

Data analysis

The RGB of chest images have been collected for analysis. The color intensity data was first checking the light condition or colored lamp effect from the RGB data of standard color chart. The medical record of blood bilirubin and another possible affecting factor were also recorded. The color intensity was then analyzed using simple regression with blood bilirubin as X axis (independent variable) and RGB color as Y axis (dependent variable). The regression analysis would result regression line with the coefficient of determination. The color intensity of red, green or blue with the highest coefficient of determination was selected for further prediction of blood bilirubin concentration of newborn infant.

RESULTS DAN DISCUSSION

Study participants

The mothers of the participants in this study have an average age of 32 years, in the range of 19 to 41 years. The 31 newborns observed showed the birth weight of 1526 to 3900 g with gestational ages were 31 to 41 weeks. Among the newborn participants, 69% of them were cesarean birth and the rest were natural birth. About the hyperbilirubinemia of the participants, the blood bilirubin concentrations measured by the hospital method were 11 to 25.9 mg/dL with an average of 16.6 mg/dL. The hyperbilirubinemia symptoms reported from 2 days to 26 days from birth, with average of 6.9 days. The newborn data profile collected could be used for further analysis related to their hyperbilirubinemia.

Chest image capture and analysis

Chest image of newborn participants have been captured with smartphone camera under the approving of their mothers. The research assistant explained the research objective and procedure prior to chest newborn image capturing. Participants in this study were voluntary, there was no compulsion from the researcher nor the hospital. Previous study reported the chest was the best site for bilirubin determination using BiliCheck^{TM} compare to another body site of the infant [15], therefore, we use the chest image of the newborn infant to predict the bilirubin concentration using smartphone camera. The chest images have been captured several times to get the best picture position and lighting.

The camera image could be interfered with environmental such as light condition and colored lamp. Several strategies have been reported to compensate the environmental effect such as the use of software correction [17], red label based white balance [18], white paper [10] and standard color chart [14]. The standard color chart was used in this research to correct the images by adding or reducing the color intensity, when the value of color intensity of white and yellow color was significantly (more than 3 point) different with another images.

The standard color chart of the white box color intensities was red of 201.5, green of 237.5 and blue of 239. The yellow color box in the standard color chart was also used as reference with the observed color intensities of red of 202, green of 200.7 and blue of 0.8.

Regression analysis

The newborn infant chest images color intensity was plotted to the corresponding blood bilirubin concentration. Among the red, green and blue color intensity, the blue color showed the best sensitivity and correlation (highest coefficient of determination) compare to that of red and green color intensities (**Fig. 2**). Therefore, the yellowest chest image, the lowest blue color intensity, the highest corresponding bilirubin concentration.

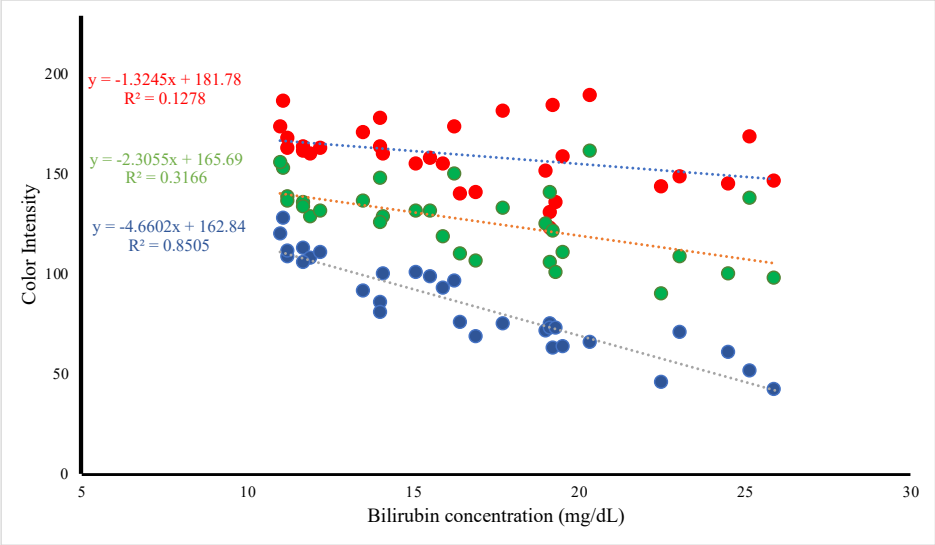

Figure 2. Relationship between newborn chest images color intensity and blood bilirubin obtained by hospital laboratory (n=31). Dotted line represents best fit by linear regression.

Neonatal jaundice etiology

Neonatal jaundice is characterized by yellow color of newborn skin and sclera. The yellow color occurs because the high level of blood bilirubin of the newborn. Neonatal jaundice common event occur in the first week of birth [19] and it is common reason of infant hospitalization. The excess of bilirubin is cause by imbalance of bilirubin metabolism, where the production of bilirubin is greater than the excretion of bilirubin. The imbalance of metabolism due to the immature liver for rapid breakdown the red blood cells due to several factors [20], such as gestational age [20]. Neonatal born before 38 weeks may not be able to process bilirubin quickly compare to full term infant. The premature infant also may feed less and fewer bowel movement, resulting less bilirubin elimination [21]. The newborn participants in this research showed that the average of gestational age was 37.8 weeks, with the minimum of 31 weeks and maximum of 41 weeks. Induced labor was also reported slightly increase the neonatal jaundice incidence [21]. The result of data analysis in the participants showed the 43,5% neonatal from the induced labor.

CONCLUSION

Newborn chest images obtained by smartphone camera could be used to estimate the blood bilirubin concentration. The blue color intensity of chest images showed the best correlation with the blood bilirubin concentration compare to the red and green color intensity. Obtained regression equation of y = -0.466x + 162.84 used to estimate the blood bilirubin concentration in infant, with y was blue color intensity and x was bilirubin concentration (mg/dL). The use of camera smartphone would help for neonatal jaundice in rural area with limitation of medical instrumentation to determine the blood bilirubin in infant.

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REFERENCES

1. World Health Organization, *World Health Statistics 2015* (World Health Organization, 2015).
2. Indonesian Ministry of Health, *Profil Kesehatan Indonesia Tahun 2019* (2019).
3. T. Utami, *J. Viva Med.* **6**, 26 (2013).
4. A.E. Raditya, (2015).
5. P.A. Pattinama, A.H. Putranti, and G.I. Sarosa, *Sari Pediatr.* **14**, 122 (2016).
6. S.N.L. Sari, Y.D. Memy, and A. Ghanie, *J. Kedokt. Dan Kesehat. Publ. Ilm. Fak. Kedokt. Univ. Sriwij.* **2**, 121 (2015).
7. B.O. Olusanya, S. Teeple, and N.J. Kassebaum, *Pediatrics* **141**, (2018).
8. M.J. Maisels, *Pediatr. Rev.* **27**, 443 (2006).
9. V.A. Moyer, C. Ahn, and S. Sneed, *Arch. Pediatr. Adolesc. Med.* **154**, 391 (2000).
10. M.D. Anggraeni and A. Fatoni, in *IOP Conf. Ser. Mater. Sci. Eng.* (2017).
11. H.W. Yulia and A. Fatoni, *J. Farm. Sains Dan Komunitas* **15**, 7 (2018).
12. A. Fatoni and M.D. Zusfahair, in *J. Phys. Conf. Ser.* (2020), p. 12030.
13. A. Soni and S.K. Jha, *Anal. Chim. Acta* **996**, 54 (2017).
14. J.C.A. Fernandes, J.A.B.C. Neves, M.J.S. Freitas, and J.L. Afonso, in *2008 IEEE Int. Symp. Ind. Electron.* (IEEE, 2008), pp. 1025–1028.
15. R.L. Poland, C. Hartenberger, H. McHenry, and A. Hsi, *J. Perinatol.* **24**, 541 (2004).
16. G. Inamori, U. Kamoto, F. Nakamura, Y. Isoda, A. Uozumi, R. Matsuda, M. Shimamura, Y. Okubo, S. Ito, and H. Ota, *Sci. Adv.* **7**, eabe3793 (2021).
17. J.-H. Seo, Y.-B. Park, and Y.-J. Park, *Eur. J. Integr. Med.* **6**, 322 (2014).
18. Y. Zhao, J. Tao, and P. Tu, *Photodiagnosis Photodyn. Ther.* **10**, 96 (2013).
19. A.K. Akobeng, *Am. Fam. Physician* **71**, 947 (2005).
20. S.Y. Mojtahedi, A. Izadi, G. Seirafi, L. Khedmat, and R. Tavakolizadeh, *Open Access Maced. J. Med. Sci.* **6**, 1387 (2018).
21. B. Wood, P. Culley, C. Roginski, J. Powell, and J. Waterhouse, *Arch. Dis. Child.* **54**, 111 (1979).